Electrical Engineering

April
1941

EE North Eastern District Meeting, Rochester, N.Y., April 30 – May 2

COPPERWELD OVERHEAD GROUND WIRE

with a life as long as the conductors it protects

string it . .
. . and forget it

The permanent high strength of Copperweld non-rusting overhead ground wire provides safe, efficient, and economical protection — *for the life of the line.*

In Copperweld overhead ground wire (strand) every wire is protected by a thick layer of pure copper* molten-welded to a tough steel core. Since Copperweld is non-rusting, its high strength is permanent, permitting the selection of smaller sizes. Copperweld's high strength, stability, and permanence make it the ideal overhead ground wire.

An interesting new bulletin containing construction methods, wire tables and other valuable engineering data has just been published and a copy is yours for the asking. In writing for it, please mention Bulletin ED 1678.

**Every wire is tested and the thickness of copper is guaranteed.*
(See Copperweld Steel Company's Specification BW-35.)

COPPERWELD STEEL COMPANY

Glassport, Pa.

COPPER · BRONZE · COPPERWELD RODS, WIRE, AND STRAND

Electrical Engineering

Registered U. S. Patent Office

for April 1941—

The Cover: Magnolia trees in bloom in the center of a parkway in Rochester, N. Y., site of the AIEE North Eastern District meeting April 30–May 2, 1941

Speculations Concerning Employment Dynamics ...Robert W. King ...151
Airdrome and Aircraft Lighting ...Wilbur T. Harding, A. D. Dircksen ...157
Radio in Remote Meteorological Indications ...Harry Diamond ...163
Technology of Motion Pictures ...Douglas Shearer ...168
Engineering Training for National Defense ...A. A. Potter ...173
Miscellaneous Short Items: Power Plant at the New Port of Buenos Aires, 156——Empire State Lightning Studies Continued, 162——Combination Lighting Designed for Art Gallery, 172——More Baseball Fields Lighted, 174
Institute Activities ...175
Of Current Interest ...188

Transactions Section *(Follows EE page 196; a preprint of pages 137–84 of the 1941 volume)*

Rating Arc-Welding Generators and Transformers ...R. C. Freeman, A. U. Welch ...137
Program Transmission Circuits ...F. A. Cowan, R. G. McCurdy, I. E. Lattimer...142
Prime-Mover Speed Governors ...R. J. Caughey, J. B. McClure ...147
Analysis of Short-Circuit Oscillograms ...W. W. Kuyper ...151
Secondary Networks for Industrial Plants ...C. A. Powel, H. G. Barnett ...154
Electron Microscope for Laboratory Service ...V. K. Zworykin, J. Hillier, A. W. Vance ...157
Displacement and Diffusion in Arc Extinction ...Joseph Slepian ...162
System Stability ...F. W. Gay ...168
Water-Cooled Steel-Tank Rectifier Corrosion ...Emil J. Remscheid ...173
Relaxed Initial Conditions in Transient Problems ...Walter C. Johnson ...178
The Varioplex ...E. R. Shute ...181

VOLUME 60 NUMBER 4

Published Monthly by the

American Institute of Electrical Engineers

(Founded 1884)

ROYAL W. SORENSEN, President H. H. HENLINE, National Secretary

——PUBLICATION COMMITTEE——

D. M. Simmons, *chairman* J. W. Barker O. W. Eshbach H. H. Henline H. W. Hitchcock S. H. Mortensen
A. G. Oehler H. S. Phelps H. H. Race S. P. Shackleton M. W. Smith I. Melville Stein S. B. Williams

——PUBLICATION STAFF——

G. Ross Henninger, Editor F. A. Norris, Business Manager
Floyd A. Lewis, Associate Editor C. A. Graef, Advertising Manager

Entered as second class matter at the Post Office, Easton, Pa., April 20, 1932, under the Act of Congress March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538, P. L. & R. Act of February 28, 1925. ¶ Publication Office: 20th & Northampton Streets, Easton, Pa. Editorial and Advertising Offices at the headquarters of the Institute, 33 West 39th Street, New York

¶ Statements and opinions given in articles and papers appearing in "Electrical Engineering" are the expressions of contributors, for which the Institute assumes no responsibility.

¶ Correspondence is invited on all controversial matters.

High Lights • •

Motion-Picture Technology. Gross box-office receipts of the motion-picture industry, one of the largest industries in the United States, totals more than $1,000,000,000 annually. Weekly attendance at the 18,000 theaters throughout the country totals some 85,000,000. Many technical and engineering problems are involved in the production of the 600 to 800 feature pictures now being filmed annually (*pages 168–72*).

Employment Dynamics. "Surveying industrial history, one detects certain trends suggestive of saturation with its inevitable bearing upon the employment problem," says a prominent AIEE member in speculations on this subject. He foresees the possibility of an increasing proportion of the people living in semirural communities where "while they might have their hand at the lathe or bench, would have both feet on the ground" (*pages 151–6*).

Speed Governors for Large Systems. The development of large interconnected power systems has created increasingly rigorous operating requirements; in spite of supplementary controls, the speed governors of the prime movers constitute the backbone of system control. Conclusions have been reached regarding performance characteristics of prime-mover governors for the larger systems (*Transactions pages 147–51*).

Finding Initial Derivatives of Transients. A new and simple method has been developed by which the initial derivatives can be found for an initially relaxed system of transients by a manipulation of the final differential equation itself; solution for a nonrelaxed system can be found by superposition or by means of a systematic change in the original differential equations (*Transactions pages 178–81*).

Rating Welding Machinery. A method of rating arc-welding generators and transformers has been proposed which includes, in addition to a current rating indicative of short-time welding capacity, a service-factor rating indicative of the continuous current-carrying capacity of the apparatus, as limited by thermal considerations (*Transactions pages 137–41*).

Electron Microscope for Laboratories. Improvements in the electron microscope (*EE, Nov. '40, p. 441*) have resulted in an instrument which is self-contained, occupies a relatively small amount of space and has an improved magnetic objective lens which increases its resolving power (*Transactions pages 157–62*).

Short-Circuit Oscillograms. Methods of analyzing short-circuit oscillograms of synchronous machines in accordance with the two-reaction theory have been developed and are compared with the more usual methods of analysis based on theories of symmetrical components (*Transactions pages 151–3*).

Stability of Power Systems. Studies have been made of system and apparatus performance during the period between the time allotted for the functioning of the high-speed relay protection and the point at which the system becomes so unstable that a major shutdown occurs (*Transactions pages 168–73*).

Operation of the Varioplex. A new method of telegraphic operation provides to each two stations connected by it an ever-ready two-way channel, which has a band-width of zero when idle and of variable dimension when busy; it is being adapted through telemeter service to use of private subscribers (*Transactions pages 181–4*).

Reducing Rectifier Corrosion. Chemical treatment with sodium chromate of the water used to cool steel-tank power rectifiers has been found to give excellent results in preventing corrosion from limiting the effective life of rectifiers of this type (*Transactions pages 173–8*).

Distributing Power to Industrial Plants. The secondary network system of distribution, such as is used in metropolitan areas, has been applied to industrial plants, and found to possess advantages of economy, flexibility, and reliability, over the commonly used radial type of distribution system (*Transactions pages 154–6*).

Upper-Air Weather Observations. Radio sondes, balloon-carried measuring devices which translate variations in meteorological conditions into corresponding radio signals, are being used to secure observations from the upper air; their use is also being extended to isolated locations (*pages 163–7*).

Arc Extinction in Flowing Fluids. Evidence has been assembled in favor of the theory of "diffusion" as contrasted with that of "displacement" to account for the effect of the circumambient fluid upon the circuit-interrupting ability of an arc (*Transactions pages 162–7*).

Design of Program Networks. The ways in which the various requirements of radio-broadcasting have influenced the engineering development of the networks have been reviewed and factors affecting further development surveyed (*Transactions pages 142–7*).

Airdrome and Aircraft Lighting. Paralleling the rapid strides made by the aircraft industry in recent years and in the facilities provided at airdromes, have been advances in the lighting art to meet the special needs of aircraft and to aid in night flight (*pages 157–62*).

Training Engineers for Defense. The role of the engineering colleges in meeting the need for engineers in the Army, Navy, and defense industries is discussed in relation to the Government program of vocational training below college grade (*pages 173–4*).

Corrections. On page 114 of the March 1941 TRANSACTIONS section of ELECTRICAL ENGINEERING, in the paper "The Electric Strength of Air at High Pressure—II" by H. H. Skilling and W. C. Brenner, the illustration listed as figure 3 should be figure 4, and the one listed as figure 4 should be figure 3. On page 507 of the December 1940 issue of ELECTRICAL ENGINEERING, in the article "Nomography for the Electrical Engineer" by Guido Ferrara, each of the values in the "L" scale of figure 6 should be ten times that shown in the figure.

Coming Soon. Among special articles and technical papers currently in preparation for early publication are: an article depicting the effects of complacency in confusion by Robert E. Doherty (F'39); an article on the measurement of cloud heights by M. K. Laufer and L. W. Foskett; an article on application of electric power in aircraft by T. B. Holliday; an article discussing static electricity in rubber-tired vehicles by Robin Beach (F'35); an article describing the new types of building wires recognized by the 1940 National Electrical Code and outlining their significance to the electrical engineer by M. M. Brandon (M'34); a report on factory wiring for resistance welders, part of the report of the subcommittee on power supply for welding operations of the AIEE committee on electric welding; a paper on modern relaying for a-c secondary network systems by D. L. Beeman (A'31); a paper embodying a new principle of cable design by W. A. Del Mar (F'20); a paper on the protective link, a new circuit-interrupting device, by J. K. Hodnette (M'30) and M. G. Leonard (A'34); a paper on an improved polyphase directional relay by B. V. Hoard (M'36); a paper on the development of the glow-switch by R. F. Hays (A'36); a paper on positive and negative damping in synchronous machines by M. M. Liwschitz (M'39); a paper describing a vertical flow outdoor compressed air breaker by L. R. Ludwig (A'28) and B. P. Baker (A'38); a paper on a conserved pressure air-blast circuit breaker for high-voltage service by W. R. Rankin and R. M. Bennett (A'37); a paper describing five years' experience with ultrahigh-speed reclosing of high-voltage transmission lines by Philip Sporn (F'30) and C. A. Muller (M'36); a paper on high potential testing equipment for quantity production by C. M. Summers (M'39); a paper on variations of atmospheric temperature with altitude in the United States by H. W. Tenney (M'36); a paper on methods of system control in a large interconnection by Earle Wild (M'36); and a paper on the control of switching surge voltages produced by the current-limiting power fuse by E. A. Williams, Jr. (A'37) and C. L. Schuck (A'39).

Subscriptions—$12 per year to United States, Mexico, Cuba, Porto Rico, Hawaii, Philippine Islands, Central and South America, Haiti, Spain, Spanish Colonies; $13 to Canada; $14 elsewhere. Single copy $1.50. ¶Address changes must be received by the 15th of the month to be effective with the succeeding issue. Copies undelivered because of incorrect address cannot be replaced without charge. ¶ELECTRICAL ENGINEERING is indexed annually by the Institute, weekly and monthly by *Engineering Index*, and monthly by *Industrial Arts Index;* abstracted monthly by *Science Abstracts* (London). Copyright 1941 by the American Institute of Electrical Engineers. Printed in the United States of America.

Number of copies this issue 24,200

Speculations Concerning Employment Dynamics

ROBERT W. KING
MEMBER AIEE

ENGINEERS are well schooled in the distinction between statics and dynamics. Hence a title has been chosen which suggests that the problem of maintaining employment is dynamic in character and involves the discovery of reactions which can be used to balance certain varying social forces.

The cycle of availability of work followed by scarcity has doubtless operated as unremittingly down through the ages as peace and war. And at long last, as in the case of war, we are beginning to realize that any considerable and sustained degree of unemployment presents a serious threat to the foundations of liberal society. The discovery of adroit means to damp employment oscillations is a first-line problem in every industrial nation. In fact, there are cogent reasons for believing that the threat of war is itself inherent in insecurity of employment. Peace both within and without are therefore mutually at issue.

At the outset of this analysis, it may be well to note that the problem is not simplified by the fact that human beings are so constituted as to let the profit in hand outweigh considerations of ultimate good. Because of this characteristic, society frequently finds itself seriously out of phase with the law of diminishing returns, and troubles become extreme before the need for adjustment or correction is recognized, or at least admitted.

This discussion, based upon an address delivered before Professor Philip Cabot's Business Men's Group at the Harvard Business School, is presented here for the purpose of stimulating thought among AIEE members on a problem of importance to all engineers; the "Letters to the Editor" columns are open to contributions on this current topic.

One permanent cure for unemployment was suggested in an inimitable verse which appeared in *Punch* just prior to the outbreak of the war in Europe—and no apology is made for reproducing it here.

'ONLY A SUGGESTION'

By Evoe

I thought as I sat by the shore of the sea
What a wonderful, beautiful thing it would be
If the Briton, the Teuton, the Gaul and the Slav
Should take all the guns and the tanks that they have
And sink them out there in the infinite main,
And then begin building them over again.
For no one, you know, is desirous to fight,
They are only protecting the Truth and the Right,
And nothing but armaments endlessly made
Can stop Unemployment and benefit Trade,
And the Heart of a Nation as never before
Is united when making Munitions of War.
How happy the state of the world when it finds,
What is simple to all mathematical minds,
That you cannot go on making gun after gun,
Because there is nowhere to put them when done,
And the largest of factories, even the Banks,
Would refuse in the end to find storage for tanks.

But a little more trust between nations, I think,
Would allow them to meet every August and sink
In a suitable place they could easily settle
Enormous supplies of explosives and metal,
And a cup would be given—the winner to count
As the one that got rid of the largest amount,
And could soonest return to the Blessings of Peace
Which are instantly doomed should Rearmament cease.

I thought as I sat by the shore of the sea
What a wonderful, beautiful thing this would be
For Commerce and Culture, and Friendship and Cash;
And the children, no doubt, would be pleased by the splash.

Unfortunately for the world, this rhymed proposal came too late to save Europe.

A SIMPLE PROBLEM OF UNEMPLOYMENT

An imaginary situation will serve as a useful beginning. No apology is offered for its simplicity, save the parenthetical remark that science usually begins with the simple and only as it masters elementary cases does it attempt those that are more involved.

Let us suppose that there was once a society which lived comfortably off the land. Their pursuits were wholly agricultural, aside from the fact that they had mastered the art of making houses for themselves. They had, to be sure, their abundant years and their scarce ones, but these were made not too troublesome by a system of carry-overs. Into this simple society we will suppose two inventions to have been introduced at about the same time. One of these involved a farm process which reduced the man-hours necessary to insure an adequate food supply. The other invention took the form of an object of household utility, let us say the clock.

The clock proved to be not only useful but an object of novelty, so that every household wanted at least one. Fortunately the agricultural invention which resulted in an economy of labor on the farm provided a labor surplus which, in turn, could devote itself to making clocks. Those individuals who were no longer essential on the farms succeeded, in a little while, in acquiring the mechanical dexterity which the nascent horological trade required. Thus, a satisfactory labor balance was established.

But only temporarily, for the clock proved to be inherently a long-lived contrivance. Once a household had acquired its timepieces, its needs were satisfied for an indefinite future. Those who had been displaced or had

---

ROBERT W. KING is assistant vice-president of American Telephone and Telegraph Company, New York, N. Y.

allowed themselves to be displaced from agriculture and who had initiated the clock trade, discovered after the lapse of time that their business was languishing. To the extent that the clockmakers had equipped themselves with little shops at home where they lived as members of a family group, no particular uncertainty resulted, for when trade was slack, they could fall back upon their families for support. But we must imagine that there were more enterprising fabricators of clocks who, realizing the economies inherent in division of labor, set up small factories in which they employed various of their neighbors. With these neighbors all went well for a time, but when clock saturation arose, they were destined to live either upon their savings or upon charity.

In spite of its extreme simplicity, this clock parable presents a challenge. The problem before this simple society is to restore the economic value of the clockmaker's time. Viewing their predicament from our own advanced position, we are prepared to make several suggestions. Some of us, being internationally minded, would advise the hypothetical society to cast about for another social group or nation that needed clocks and that could export some other commodity or gold in exchange. Others, discerning a fringe of marginal farmers who are less abundantly provided with clocks than the rest, might advance arguments in favor of technological improvements to the end that cheaper clocks could be placed upon the domestic market. Still others would see an obvious line of escape in further invention, resulting in some new device to replace the clock as an article of trade. And finally there would assuredly be a suggestion that hours of labor must be rationed so that everyone could have some.

Each suggestion has merit and offers some relief. The difficulty arises when we inquire as to how much relief each can or should be called upon to supply. And of course there is the additional problem of determining how each ameliorative process should be made to vary as a function of time.

A POSSIBLE LIMIT TO MATERIAL WEALTH

It is with the second and third processes and their time variations that technology is particularly concerned. As a beginning let us draw a picture of our own future untrammeled by any inhibitions. Let us vision an era in which the most modest family income will encompass not only a comfortable house and garden, but a small summer cottage or hunting lodge, at least one motor car, a cabin cruiser or such other nautical equipment as meets the family taste—in a word, a physical plant which on the basis of present-day values might represent an outlay in the neighborhood of $10,000. We need not, for the moment, pause to consider how it became possible for families, generally, to acquire so extensive a menage. Our interest is directed to the consequences, not the causes, of the situation. We are struck at once with the heavy maintenance problem that would face the nation. Taking $10,000 per family purely as a convenient average for purposes of argument, and remembering that there are approximately 32,000,000 families in the United States, the resultant physical plant would be worth $\$320\times10^9$. In contrast to this sum, the manually created physical assets of today (there are four principal categories excluding land and natural resources) have the following approximate values:

Buildings and other improvements on land	$\$64\times10^9$
Structures of public utilities	46
Factories and other production assets	24
Durable family possessions, household furnishings, motor cars, etc.	25

Now assuming rates of maintenance and depreciation on these items of 3 per cent, 5 per cent, 15 per cent, and 10 per cent respectively—figures which are probably conservative—one discovers that effort equivalent to about $\$10\times10^9$ per year is required to maintain our *status quo.*

This calculation gives a ready index of the consequences of multiplying the average family holdings by any assumed factor. Even such an increase as a restrained imagination might fancy would, we see, involve maintenance and replacement expenses greater than the present entire national income. So, much as in the mind's eye we would like to multiply our physical possessions, we sense that there must exist some limit beyond which we cannot go. The vision of American industry, running at ever higher speed and turning out a greater profusion of gadgets and paraphernalia of all descriptions, appears to have at best a somewhat unsubstantial foundation. At some stage perhaps near, perhaps remote, industrial expansion threatens to bring us into approximate coincidence with a kind of ceiling which owes its existence in part to the inescapable character of maintenance and depreciation. Since the situation is not static, because the rates which we must set for maintenance and depreciation are subject to the attack of science, it is necessary to envisage a sort of race between the activities of science which are multiplying material aids, and those which are endowing them with longer life. Nevertheless, as we acquire material wealth, we must expect to have brought home to us more and more that we are in a situation similar to that of Alice and the White Queen who had to run faster and faster to stay where they were.

TECHNOLOGY ASSOCIATED WITH SWINGS OF INCREASING VIOLENCE

In passing, it will be as well to note that one of the most direct consequences of the maintenance problem has a serious employment aspect. Much of the nation's expenditure for maintenance is obviously for consumer goods, and one form which enforced economy invariably takes is that of curtailed care to existing structures. Individuals and corporations alike are inclined to forego all but urgent upkeep and repairs during times of economic stringency. This fact may well account in part for the severity of the latest depression and have a bearing on the depth and duration of future depressions; for obviously the larger the labor requirements that enter into annual maintenance the larger is the potential element of unemployment if for any reason maintenance is postponed. It is but fair to note, however, that such postponement should in the normal course of events bring about an equally sudden demand for labor, once pessimism has given way to optimism.

Nevertheless, unless we can introduce counteractive measures, the situation thus created is one conducive to oscillations of increasing violence.*

The phenomenon just mentioned has frequently been noted and is, indeed, one of minor significance in the long term view of technology as it affects employment. So let us turn to consider the partition of social effort between activities of production and activities of distribution. Examination of this partition shows evidence of a marked evolutionary trend over the years. Although the callings of the jobber and the retail merchant—even the advertising man—trace back to earliest historical times, they once played a less conspicuous role in the sum total of society's activities than they do today. Sales stimulation has assumed steadily increasing proportions and importance. The same applies to all other agencies of distribution, such as transportation and communication, and also to the professions and the service agencies. Indeed, today the trend has carried us so far that, as a recent survey by the Twentieth Century Fund shows, out of every consumer dollar, about 59 cents go to defray the expenses of distribution and service while only 41 cents go to the agencies of production.

INCREASING SALES RESISTANCE

Such figures are challenging. They suggest a well-advanced stage of the ceaseless and age-old struggle for the consumer's dollar. There may never have been a time when consumer goods, in effect, sold themselves; but with the growth of modern industry and mass-production, a need has arisen to bestow increased effort upon techniques for stimulating the distribution of consumer goods; so much so that, whereas in 1870 the forces in production and sales stood as 3:1, the ratio in 1900 had become 2:1, and now stands at 1:1.† In other words, industrial maturity of the nation shows up indirectly in an increasingly keen competition for the still unpreempted sector of public appetite—a sector which, as we shall see later, may be growing smaller as the average consumer holdings of material possessions expand.

Such an interplay of forces, while more deep-seated, may be likened to the engineer's effort to attain what he calls an "economic balance." Take, for example, the competition which leads to the erection of a filling station on each of the four corners of a single busy crossing. Such construction must mean that a readier opportunity of employment is to be found in the intensive development of filling stations than can be created by increasing investment in productive capacity. But so far as the consumer of oil products is concerned, would he not be better off if the number of filling stations throughout the land were reduced to one-half or one-third their present number and the resultant savings handed on in the form of a lower retail price? However, the struggle for employment—the modern form of the struggle for existence—appears to preclude this otherwise logical suggestion. Taking all present factors into account, there is perhaps no better way that many persons can impart an economic value to their time than by manning unnecessary, but not unpatronized, filling stations.

Thus, while it is easy to declare that the nation is supporting many more distributive outlets than need be, and that if this surplus were done away with, prices to the consumer could be lowered, such a proposal ignores the fundamental fact that there is no present possibility of offering other employment to those displaced by this measure toward economy; and until other avenues of employment appear—and these, to effect a realignment must, of course, appear in production—our preponderant distributive forces must, perforce, remain preponderant.

This argument leads us to examine anew the common supposition that those technological contributions which have been labor-saving have, in general, proved to be job-creating, and that among the resultant train of events a shortened work-day and increased wages are conspicuous. The implication is not uncommon that technology has *permitted* the shorter work-day. Yet, if this be so, how do we explain what appears to be the ever-present threat of overproduction? Let us imagine the consequences of suddenly lengthening the hours of labor. Thus, had production of consumer goods gone forward in 1928 or 1929 upon the basis of a 12-hour day, one fears that the consequence would have been a glut in virtually all markets, irrespective of the fact that the income available to purchase these goods could have increased proportionately. It might be more accurate, therefore, to say that technology has necessitated the shorter workday. This conclusion is deducible likewise from the lengthening interval of schooling for youth and from the lowered age of retirement. The presumption, therefore, is that given our present industrial setup, a sort of incipient overproduction of many—perhaps, indeed, of most—kinds of commodities we have *devised* and are *equipped to make* hovers over our economy.

Another way of stating the inference is that industry, in its present limited state of diversification, might encounter a serious number of inelastic markets were production to be stepped up very much. And still another is that with the development of labor-saving schemes, the shorter work-day has, in large part, been an unconscious adaptation on the part of industrial society to certain little-remarked inflexibilities. Hence, while it is manifestly premature to venture any dogmatic assertion, we might be well advised to harbor a suspicion that the mechanism which industrial society depends upon to maintain adequate—even expanding—employment is, in fact, near a sort of overload point.

OTHER EVIDENCE OF THE LIMITS OF ECONOMIC EXPANSION

We pass now to a third little-discussed long-term phenomenon which seems to possess fundamental significance. It is, perhaps, the most enigmatic of all. To put the matter as a question, has any industrial nation unless possessed of a rapidly growing population (and this may be interpreted as equivalent for purposes of the present discussion to an expanding geographical frontier) been able long to maintain prosperity on a basis other than a net export of manufactured goods? England, for a period of a century or more, built up a commanding position in world trade through the development of foreign markets for its manufactures; but when these foreign markets began to dwindle, as they did with the initiation of colonial and other local industries, England's prosperity went into a long and refractory decline. Likewise Germany, which before the World War was a prosperous nation with ample foreign markets for its excess industrial production, largely lost those markets during the War. With the conclusion of peace, she found herself unable to regain any semblance of her earlier prosperity—and this in spite of the fact that the needs of her own people for manufactured goods were never more desperate, and in spite of the fact that considerable foreign capital was loaned to initiate renewed manufacturing activity. The recovery of lost foreign markets proved a slow and laborious process, with the result that her industrial machine lay strangely impotent in the face of pressing domestic demands.

---

*Recent evidence of a nationwide curtailment of maintenance and replacement is found in Department of Commerce data. If these may be taken at face value, they show a serious erosion of national wealth. For the five years from 1930 to 1935, a net loss is reported each year; the largest was $9,000,000,000 for 1932, the smallest was $1,500,000,000 in 1934, with a five-year total of $26,000,000,000.

†See the Industrial Conference Board's "Enterprise and Social Progress," p. 48.

The evidence from Nazi Germany is no more reassuring, for prior to the advent of the war, the industrial machine was satisfied by an inordinate emphasis upon the manufacture of armaments—an observation which prompts the question as to whether it might not have been about as well satisfied by the enforced manufacture and almslike distribution of consumer goods, and with far more welcome consequences both at home and throughout the world.

The case of the United States to date differs from that of either England, Japan, or Germany, for we have had, until very recently, geographical frontiers or the equivalent in undeveloped natural resources which have induced a rapid growth of population with expanding markets for manufactures, markets which, in certain respects, are equivalent to those on foreign soil. Our population growth, however, is now leveling off and the question arises as to whether in the decades to come, the maintenance of youthfulness in our industrial machine may not prove as much of an enigma as it appears to have done in older countries.

ARE THERE UNDEVELOPED DOMESTIC MARKETS?

But what of the "have-nots" and the potential market which they offer? The existence of these "have-not" groups, with the apparent promise of wider home markets which it implies negatives in some minds any belief that national industrial output should be regarded as in an incipient state of leveling off. Consideration of this problem can perhaps best be initiated by discussing a specific illustration.

A recent report of the National Resources Commission which concerns the northern portions of Michigan, Wisconsin, and Minnesota, offers a convenient approach. The report points out, in effect, that so far as concerns most of the $1^1/_2$ million people who live there, there is little that they can make, or grow, that the rest of the country particularly wants. A generation or so ago the people there were confident and optimistic. They found forests, fish and mines, and some good farm land. So, as becomes a self-respecting community, they built schools and roads, and went in debt to do so. First the forests disappeared, then the fish, and finally machine methods of mining largely replaced hand labor.

This portrays one socially important type of the "have-not" problem. The $1^1/_2$ million people who inhabit the region in question lack many things that those more fortunately situated geographically take for granted—things which they very much want, and for which they would be willing to work, but for which they cannot work under present conditions. One direct plan for bettering their lot would call for the erection of factories and mills in their own territory, for which they, themselves, could supply the labor. In this way, it would be possible for them to satisfy most of their present wants; but what then happens to the rest of the country, where factories and mills for making these very commodities already exist and where ample labor is available to turn out all that the entire nation needs, and frequently more that must seek foreign markets?

As matters stand in the United States today, the dispersion of industries from more industrialized regions—and among these our larger cities are perhaps the most conspicuous—to less developed areas is more than an academic matter. Prior to the incidence of the depression, a migration from northern to southern states had begun, and appears as yet to be incomplete. It is nominally explained as having taken place in response to the lower wage levels of the southern states; but this is merely another way of saying that prior to industrialization the average worker's time is not so productive, and therefore not worth so much to society. It is also tantamount to saying that the dwellers of the south, while lacking commodities being produced in the mills of more industrialized areas, had not the wherewithal to purchase them.

What, then, are we to conclude? We see new industrial regions springing up; that is, we see industry disseminating itself to sections of the population to whom it has heretofore been unable to sell its products. We see many older industrial areas undergo partial eclipse as a result of this migration, with consequent jeopardy to workers' security and property values. We see this change come about in response to certain developments of present-day technology. Is the transformation a wise one? It may mean, for instance, that the areas now launching themselves upon the road to industrialization are setting out to traverse a route which, in many respects, is like that traversed by the areas first industrialized—a route, in other words, about which we are seeking to determine whether it leads to an *impasse*, or whether after a little rough going it will open out into a sort of promised land. Thus the current industrial expansion of the southern states and other less developed areas, may turn out to be a case of rectifying one mistake by making another of similar kind. It reminds one of the limerick concerning the mouse in the stew:

A gentleman dining at Crewe
Found quite a large mouse in his stew.
Said the waiter, "Don't shout
And wave it about
Or the rest will be wanting them too."

Be this as it may, there nevertheless is impressive strength in the argument that the process of supplying manufactured goods in appropriate quantity to those whom we now class as the "have-nots," appears to offer no adequate outlet for the nation's present industrial mechanism as a whole. And, especially, to the extent that it is necessary for the "have-nots" to equip themselves through the agency of their own labor, albeit with borrowed money, their present potential consuming power—not *purchasing* power, for of this they have little—appears an industrial liability, not an industrial asset.

It is interesting to restate this argument by comparing such a depressed area to a small nation. The nation would, as economic history amply shows, follow just such a scheme, attracting in foreign capital to create the industries desired, and erecting tariff barriers if need be. Many would label this procedure an attempt at autarchy and proclaim that only through the free movement of goods across national boundaries can the world hope to maintain peace and prosperity. The procedure followed by the little nation does, however, help it for the time being irrespective of whether, in the long run, it may come to suffer from industrial indigestion in much the same way as the recent status of large nations suggests.

Without attempting to carry the argument through expanded stages, a procedure which, it seems likely, would weaken its suggestiveness without destroying its validity, the handwriting foretells a time when industry's market, by and large, will be predominantly a sort of local replacement market. In other words, the possibility of significant "exports" to less developed areas will play a diminishing part in the economy of any geographical district, and hence of a nation as a whole, if large like the United States.

Likewise, the other forces which are commonly regarded as working to lift the nation's industrial level—such other forces as science and invention—may, as has been noted, prove of uncertain value as agencies to bring about marked future expansion of employment.

THE ENGINEER'S SOCIAL OPPORTUNITY

This is a novel situation so far as the United States is concerned. With minor exceptions, American political philosophy has been guided by the vision of ever-expanding markets. Even in times of slack employment, a greater future has seemed to lie ahead, and to the nation as a whole there has come no intimation of an industrial ceiling. But surveying industrial history, one detects certain trends suggestive of saturation with its inevitable bearing upon the employment problem. Then too, as already noted, the course of industrial evolution has been such as to create employment conditions which can become markedly unstable. In a situation so complicated by imponderables, it is manifestly unwise to hasten to conclusions. Yet this is not the first time the engineer has been confronted with situations which are not reducible to exact control. With his factors of safety he manages to make allowance for his ignorance, and on the whole does so with satisfactory results. Granting that the analogy cannot be considered exact in all respects, it may not be amiss, however, to weigh the idea of social and economic factors of safety on a nationwide scale. Indeed, the use of factors of safety already extends farther than the limits of engineering. They are well known and, of course, highly developed in both banking and insurance, and their extreme serviceability in these quarters again speaks in favor of a wider application.

It is the precise manner of application which principally remains in doubt. However, in the modern state a factor of safety might well be directed at the inherently oscillatory character of many social and economic forces, and in particular at the disastrous consequences which so frequently attend these swings. The advances in technology, as thus far employed, have, we see, tended to enhance the oscillatory character until the present unimpeded surges are inimical to the maintenance of Social Solidarity. It is pertinent, therefore, to inquire whether present day technological knowledge might be so adopted as to promote less abrupt and less disruptive economic and political changes; in other words, whether a scheme of social security and social insurance can be woven deliberately into the technological fabric of the nation, not, as in recent legislation, superimposed upon it as a weight of taxation and something to be converted into a political football should occasion offer.

To mention parenthetically but a single gross defect in current social security legislation, there is the fact that while it provides a monetary compensation for loss of employment, it offers no substitute occupation but leaves the recipient in idleness. This can be considered tolerable only if no alternative security of subsistence which at the same time provides employment for the hands or mind or both can be devised.

Here the engineer might risk a suggestion. A fundamental social factor of safety must be concerned with the ready availability of food to every family. One promising approach may lie in a trend already in evidence, namely, the transfer of many factories and mills out of large cities, with the result that most bread winners, while they might have their hand at the lathe or bench, would have both feet upon the ground. Such relocation—taking place gradually, to be sure—might offer a variety of trades within relatively small compasses, and yet the land area available to each family would permit of subsistence. To make the most of such a change, the engineer should adopt a broader social outlook, for his would be the responsibility of molding many of technology's most important agencies to the needs of a vast rural rather than a highly concentrated population. It would introduce an enlarged element of social awareness and social responsibility into his problems. Conspicuous among the agencies which would have a fundamental role to fill are transportation, electric power transmission, and communication. When suitably developed and employed there seems little doubt that many, if not all, of the industrial and commercial advantages and educational and cultural amenities now found in dense urban communities could be retained by a dispersed population through the proper use of these basic auxiliaries. For those individuals constitutionally wedded to urban life there would still be cities; but for another large contingent of erstwhile urban population there would arise a new-found security and freedom.

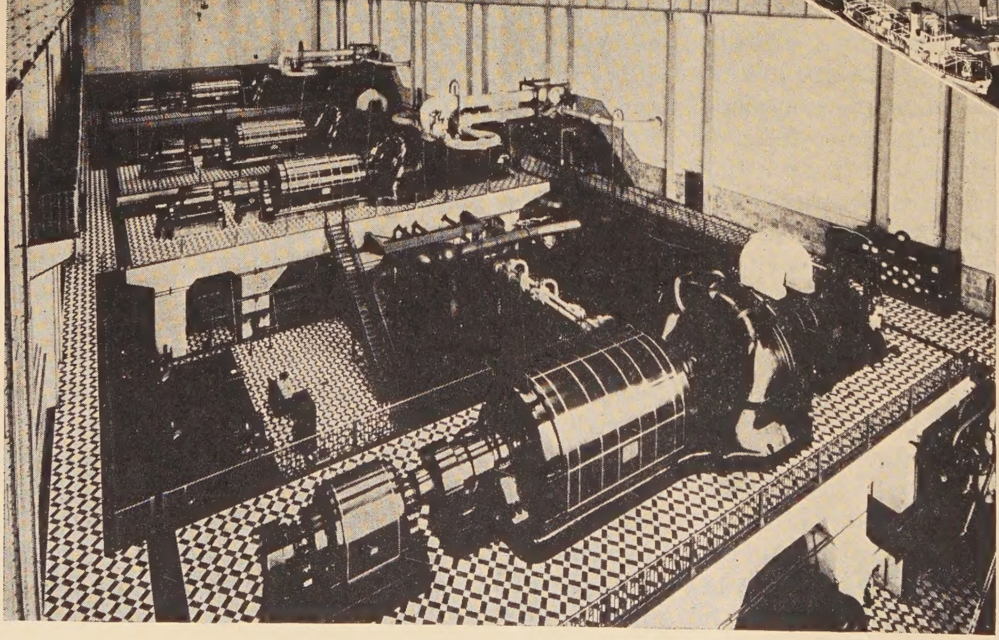
The fact that only about 20 per cent of the nation's labor is now employed in agriculture, shows the wide margin of the gainfully employed which, under such redistribution, would be available for manufacturing. And to bring industrial work into intimate contact with food supply should greatly simplify the nation's mechanism of life. The task, as we face it today, of maintaining a far-flung balance between large producing population groups, agricultural and industrial, in spite of certain operating economies which may reside therein, is so uncontrollable, and when out of control so disastrous, as to suggest a need of revision. This, indeed, may be one of the paramount lessons to be derived from the past ten years of uncertainty. By dispersion we would equip the industrial mechanism with a safety guard against the periodic spectacle of idle millions in the cities being fed from public funds, and of semi-idle millions in the country districts wanting the products of industry but lacking means either to make or buy them. At the same time, we would aid the farmers of low purchasing power by bringing a goodly portion of industry to them.* In a word, we would succeed in simplifying the geographical status of our division of labor with a resultant gain in stability. We would have traded a complicated and periodically unreliable mechanism for one which, while seeming in certain respects to revert to an earlier model, would be more rugged and better able to withstand the shocks of the road.

---

*The subsistence type of farmer would remain such, but by turning a part or all of his surplus time to account in a nearby mill or shop he could equip himself with a reasonable number of life's physical conveniences and comforts. As for the commercial farmer, he might enter the "extractive" field, and raise crops utilizable as raw materials.

Power Plant at the New Port of Buenos Aires, Argentina

SHOWN at the right is the power plant of the Compania Argentina de Electricidad located at the New Port of Buenos Aires. The plant was placed in operation early in 1929 with two General Electric turbine-generator units with steam reheating between the cylinders of high and low pressure. Today the plant, interior of which is shown below, has four units, and a fifth is being installed this year. The plant's output in 1940 was nearly 1,150,000,000 kilowatt-hours.



EACH of the turbine-generators, shown at left, is rated at 52,500 kw and 1,500 rpm; pressure 550 pounds per square inch; temperature 750 degrees Fahrenheit. The fifth unit will have a speed of 3,000 rpm. Only two of the present units have intermediary reheating of the steam. Pulverized coal has been the type of fuel chiefly used.

Airdrome and Aircraft Lighting

Although long strides have been made in recent years in the development of suitable equipment and methods of installation for the night lighting of airdromes, much remains to be done before airdrome lighting facilities can be considered ideal. The first of the following pair of articles describes lighting equipment now in use at the permanent airdromes of the United States Army Air Corps, and discusses the problem of distribution of electric energy for lighting. The second article describes the lighting equipment developed for special uses on Army aircraft.

Airdrome Lighting

WILBUR T. HARDING

FIFTEEN years ago, the equipment available for night lighting of permanent airdromes of the United States Army Air Corps was quite inadequate and the proper methods of installation were unknown. Today, although both of these deficiencies have been minimized, much is yet to be accomplished before airdrome lighting facilities reach the ultimate in performance.

Where possible, commercial equipment has been used. Due to the necessity for procurement by advertisement, detailed specifications had to be prepared to insure receipt of satisfactory articles. In such procurements, governmental engineers are handicapped more than engineers connected with private concerns who can select and procure their equipment where they desire.

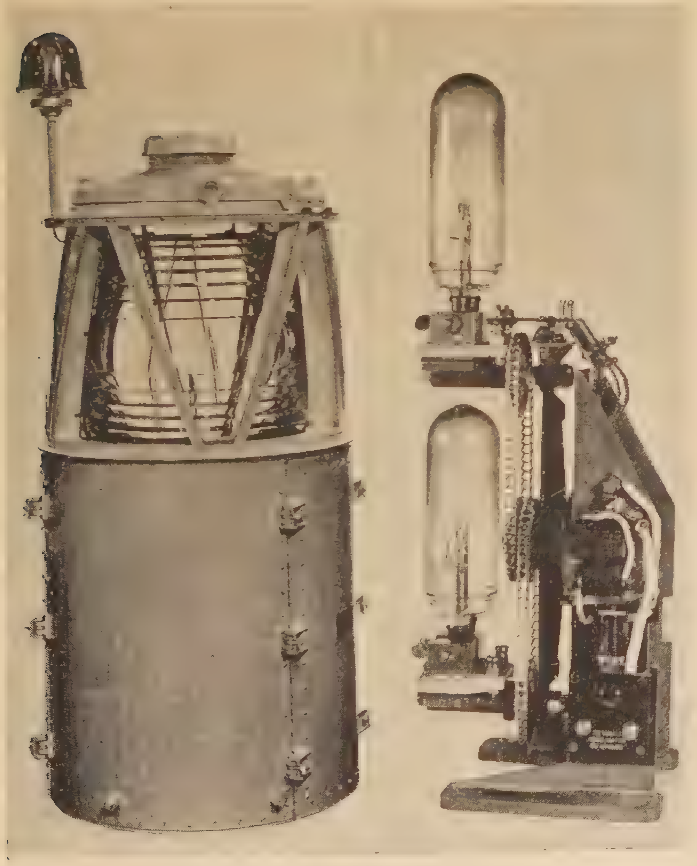


Figure 1. Lamp assembly, type D-2 beacon (left), and lamp changer (right), United States Army Air Corps

The beacon uses a 1,500-watt 32-volt lamp, and is equipped with the lamp changer shown at the right

Many items of equipment, however, had to be designed by the Air Corps or their development by commercial concerns encouraged. The procurement of equipment for a modern airdrome today involves the use of some 50 equipment specifications, all of which must be revised periodically.

Commercial designers of equipment often overlook entirely the problem of installation, or they attack it as an afterthought when the design is nearly completed. To overcome this defect, Air Corps specifications often departed materially from commercial standards, much to the consternation of some of the suppliers. The Air Corps at present has installations of night lighting equipment at approximately 40 fields. The personnel at these fields does not hesitate to point out unsatisfactory features, which are often used as a basis for specification revision or development of new equipment.

Airdrome lighting resolves itself into two major engineering problems. Of first importance is that of proper light distribution which is the concern of an illuminating engineer. The problems involved herein, however, are too lengthy for inclusion in this article, which is devoted primarily to a discussion of equipment used and the problem of electrical distribution.

EQUIPMENT

Beacon. The standard Air Corps beacon (figure 1) consists briefly of a Fresnel lens optic in which the lamp is moved periodically along the axis of symmetry.[1,2] The result is a radial beam of light that sweeps up and down through a vertical angle from 2 to 18 degrees above the horizontal. When viewed by a distant pilot, the beacon appears to flash normally 80 times a minute. The principal advantages of this beacon over the older rotating types are:

1. The beacon flashes normally 80 times per minute as compared with the 6 flashes produced by a rotating beacon.

Essential substance of a paper presented at the AIEE Middle Eastern District meeting, Cincinnati, Ohio, October 9–11, 1940.

WILBUR T. HARDING is electrical engineer, United States War Department Air Corps, Materiel Division, Wright Field, Dayton, Ohio.

1. For numbered references see list at end of article.

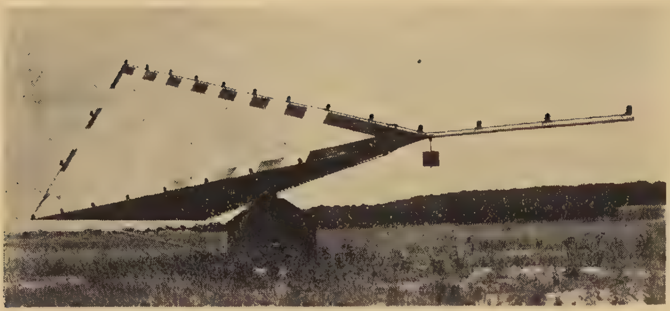


Figure 2. Wind indicator, type B-5, Air Corps, is 36 feet long, tetrahedral in shape, and constructed of steel tubing covered with fabric. It is lighted by 35 ten-watt red and green lights along the edges

2. The signal within limits is independent of altitude, which allows a pilot to approach a field at a constant altitude. The conventional rotating beacon is inclined at a fixed angle above the horizon; the pilot often is above or below the center of the beam and misses the signal in bad weather.

Wind Indicator. The standard Air Corps wind indicator is shown by figure 2. Its position can be interpreted either by day or by night from the ground or from low altitudes. This indicator was developed by the Air Corps.

Outline Lights. The usable landing area generally is outlined by a system of obstacle and boundary lights. The former mark dangerous obstacles which must be avoided, and the latter denote the limits of the landing area. Boundary lights were originally of considerable value for fields where the entire area was used for landing purposes. For fields having hard-surfaced runways, however, their use is problematical and they may be eliminated ultimately.

Floodlights. Floodlights for illuminating the landing area can be classified readily into two general types:

1. One type covers a fairly large area upon which landings can be made in any direction. Such floodlights are applicable to fields that do not have runways, such as training fields or small privately operated fields. For such applications, there have been advanced many and different solutions. In general, for fields at which the wind conditions require approaches from all directions, three or four banks equally placed around the landing area, each with selective control and each covering a sector not exceeding 90 degrees, has been found to be the most acceptable arrangement (figure 3).

2. The second type of floodlight is applicable to fields that have hard-surfaced runways at which it is desirable to restrict the floodlighting to the runway surfaces. The bridge type of installation with drum floodlights shown by figure 3 can best be utilized for this purpose. The standard practice of the Air Corps at present is to place such an installation at the approach end of the runway approximately 300 feet to the right and to utilize four spread lenses. An 80-degree lens is used to cover the runway closest to the floodlights, then 30-degree, 10-degree, and plain lenses to cover successive portions.

There is a tendency at present toward the elimination of floodlights at fields that have hard-surfaced runways and adequate runway contact lights. Many pilots prefer

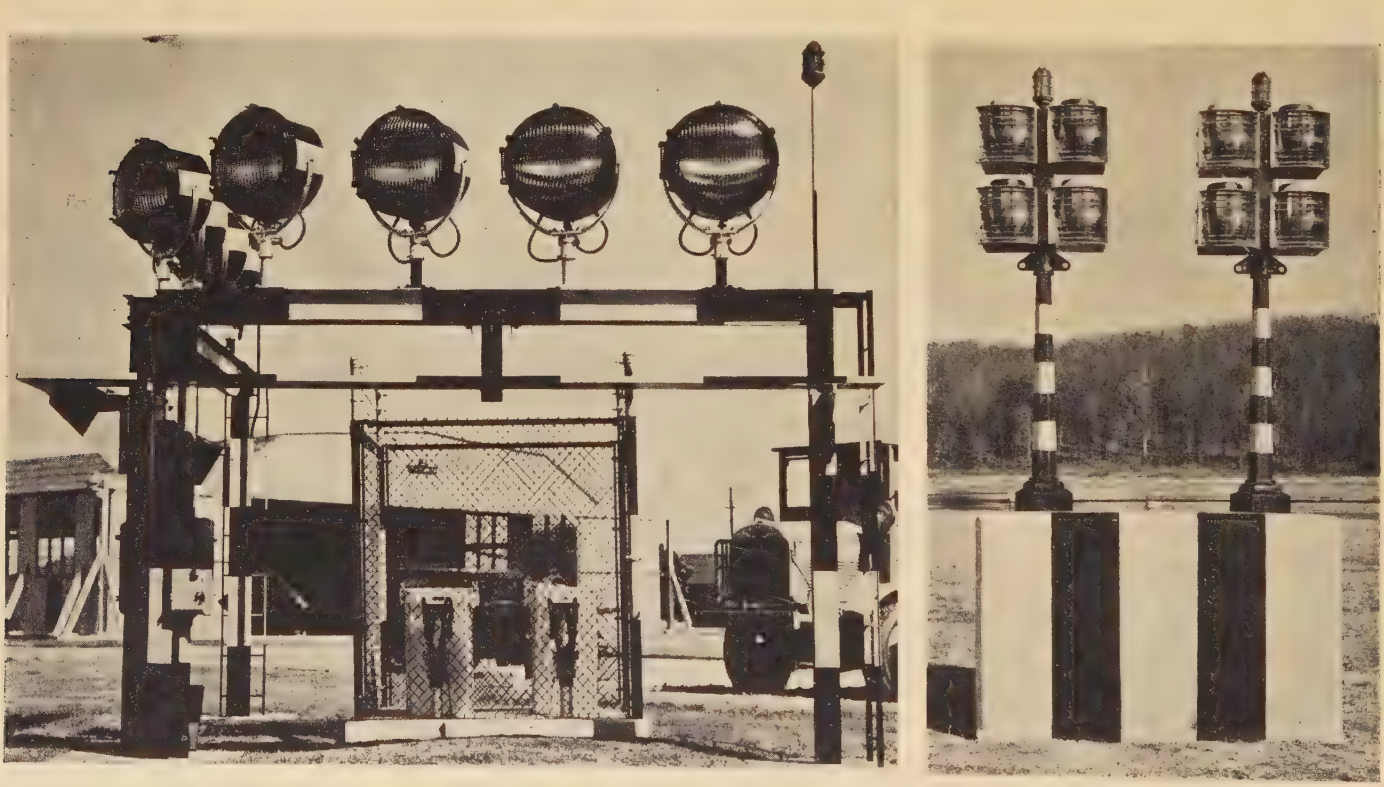


Figure 3. Floodlight installations at Kelly Field, Texas (left) and Bolling Field, Washington, D. C. (right)

In the typical installation upon a floodlight bridge shown at the left each bridge is equipped with four drum-type floodlights, each of which has a 30-degree lens and a 3,000-watt 32-volt lamp. This arrangement will cover a sector 90 degrees by 2,500 feet. For additional illumination, a second bank covering the same area may be added. A sector of the same size is covered with the use of only half as much wattage in the installation shown at the right, which is applicable to fields that are quite level. Each floodlight uses a 1,500-watt 32-volt lamp. It is less applicable to fields with irregular contours or those requiring a sector of less than 90 degrees to land without floodlights, depending upon aircraft landing lights if additional lighting is necessary. The latter, however, are unnecessary for a trained pilot if the ground contact lights are adequate.

Runway or Contact Lights. As indicated, contact lights, if adequate, form a major part of an airdrome lighting system. These lights are placed along hard-surfaced runways at regular spacings and have a specialized distribution which concentrates the light signal in the angles along which a pilot normally approaches for a landing. These lights (figure 4) are essentially marker lights denoting the position of the runway surface.

Approach Lights. Under adverse weather conditions during which aircraft may be guided toward the approach to the landing runway by radio aids, it is generally recognized to be extremely desirable to complete the landing operation by observing ground lights in lieu of making a complete blind landing. Toward this end the Civil Aeronautics Authority and Army Air Corps for several years have been attempting to devise and develop equipment. At the present time, a system of lights 1,500 to 3,000 feet long which will mark an approach path leading into the runway is being considered. It is the intent of the developments under way to have the approach lights serve as the first ground aid which, in turn, will lead into the contact-light system which will be used for completion of the landing maneuver.

Future Developments. The future of airdrome lighting depends upon the successful development of approach and contact lights which will permit operations as just described. When this is accomplished, boundary and floodlights are likely to be discarded except for training fields.

ELECTRICAL CIRCUITS

Series circuits are used for outline-light, contact-light, and approach-light systems. With these circuits, series multiple transformers are used for the following reasons:

1. In case of collision, the high-voltage series circuits are usually undisturbed.
2. Obstacle lights may be installed upon buildings without danger due to high voltage.
3. Magnetic coupling between the series circuit and lamp reduces the possibility of short-circuiting a circuit or part thereof if water grounds one or more lights. This is especially applicable for contact lights.

A typical installation of a subway type of series multiple transformer in the base of a contact light is shown by figure 5. This installation is designed to seal the cable entrance yet allow quick replacement of the transformer if necessary.

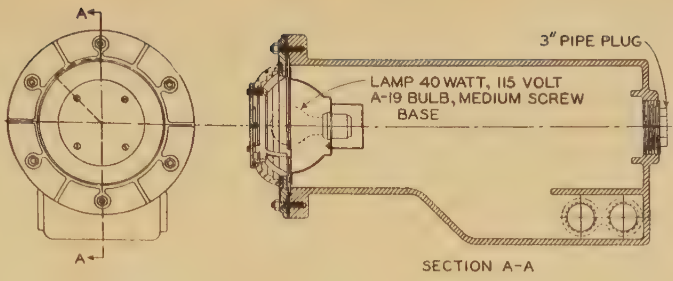


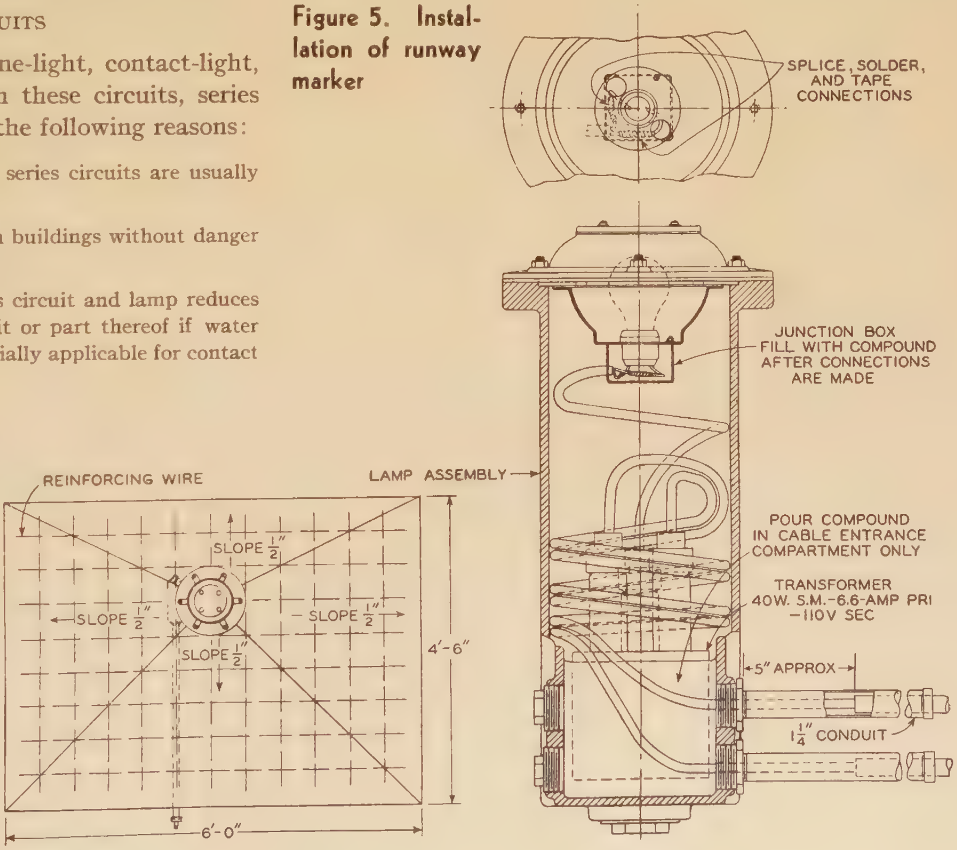
Figure 4. Lamp assembly, runway marker, type B-2

For floodlights it has been the practice to supply a 2,300-volt primary feeder from center of distribution to floodlight. At the floodlight a 2,300/32-volt transformer with taps to compensate for line drop is used. Switching is accomplished at center of distribution. Controls of the various circuits are centralized in a control tower where radio and light aids are under the jurisdiction of trained operators.

EMERGENCY POWER

The utility of an adequate airdrome lighting system is dependent upon a constant source of electric energy. The Air Corps has not been satisfied with the reliability of commercial power and has developed automatically operated equipment to supply power in an emergency. As the first step in this development action was taken to provide distribution systems operating at either 2,300 volts delta or 4,000 volts star. For fields using higher-voltage systems, the necessary step-down transformers were provided. Two items of standardized equipment as follows were then developed which could be connected at will for either voltage:

1. *Primary Cubicle.* This equipment consists of a self-contained hand or automatically operated switching device. When



SPLICE, SOLDER, AND TAPE CONNECTIONS
JUNCTION BOX FILL WITH COMPOUND AFTER CONNECTIONS ARE MADE
REINFORCING WIRE
LAMP ASSEMBLY
SLOPE ½"
SLOPE ½"
SLOPE ½"
SLOPE ½"
POUR COMPOUND IN CABLE ENTRANCE COMPARTMENT ONLY
TRANSFORMER 40W. S.M.-6.6-AMP PRI —110V SEC
4'-6"
5" APPROX
1¼" CONDUIT
6'-0"

Figure 5. Installation of runway marker

set for automatic operation, it is designed to transfer the load from the preferred (commercial) source to the emergency source in event of failure of one or more phases of the preferred source. This transfer is, of course, dependent upon the emergency source being energized and, to initiate this action, a 230-volt pilot source is provided to the emergency cubicle. The primary cubicle includes metering from the preferred source, instruments for determining the electrical load from either source, and overload protection from either source.

2. *Emergency Cubicle.* The emergency cubicle which operates in conjunction with the primary cubicle and power plant includes a battery charger, a voltage regulator, and a control panel. The latter consists of the necessary relays to start the power plant from a 12-volt battery source in event the 230-volt pilot circuit from the primary cubicle is de-energized and to provide automatic shutdown when power is resumed. The control panel provides intermittent cranking to facilitate starting, operation of the power plant at no load for three minutes after power is resumed, and automatic shutdown in event of dangerous operation such as lack of oil pressure or high temperature.

Figure 6 shows the power plant designed to operate with the cubicles just described. It is rated 93.8 kva at 80 per cent power factor. The plant, however, will carry 93.8 kw continuously at an ambient temperature of 110 degrees Fahrenheit with radiator cooling only. Additional cooling is provided by a thermostatically operated valve which bleeds in cold water when the coolant exceeds 140 degrees Fahrenheit. The equipment uses gasoline as a fuel. This equipment will handle airdrome lighting, radio, and other vital loads.

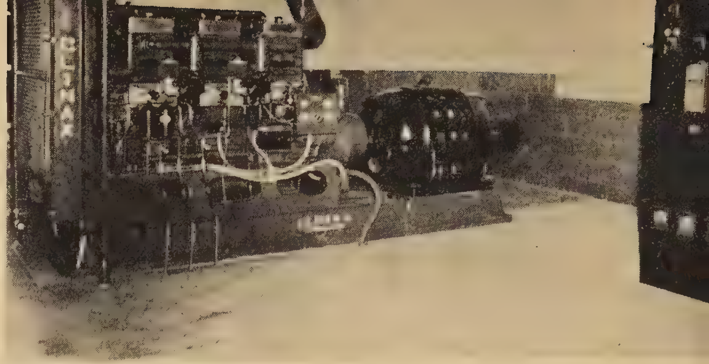


Figure 6. Power plant installation at Mitchel Field, Long Island, N. Y.

REFERENCES

1. Trends in Aviation Lighting, **F. C. Breckenridge.** *Transactions,* Illumination Engineering Society, volume 33, 1938, pages 263–76.

2. Oscillating Beacons, **W. T. Harding.** *Transactions,* Illuminating Engineering Society, volume 33, 1938, pages 277–80.

Aircraft Lighting

A. D. DIRCKSEN

AIRCRAFT lighting consists of: landing lights, position lights (wing and tail), formation lights, cabin lights (dome and worktable), indicator lamps, bomb-release signal light, interaircraft control-lamp assemblies, and instrument light.

Landing Lights. The first landing lights on aircraft were attached to the lower surface of the airfoil or to the fuselage. These lamp assemblies used 240- or 420-watt 12-volt lamps, depending on the size and type of airplane. Later, to reduce the aerodynamic drag, the lamp assemblies were built into a mount, which was fastened to the leading edge of the wing.

The next improvement was the insertion of the lamp assembly in the wings and the use of a curved cover glass to conform to the contour of the airfoil. Because of the increasing use of deicers and the use of the front surface of the wing to carry load, the leading-edge lamp assembly has been superseded by the present standard electric retractable-type landing-lamp assembly, which is mounted in the lower surface of the airfoil. Experimental tests are being conducted on sealed-beam lamps for aircraft landing lamps. The use of these lamps would permit increased wattage and light output and eliminate reflector maintenance.

Position Lights (Wing and Tail). The Air Corps recently has standardized on the single-unit-type position light which will meet the requirements of the Civil Aeronautics Administration airline forward position lights and which will also meet the Air Corps formation flying requirements when used with a dimming resistor. The Civil Aeronautics Administration requirements for tail light is not met by the Air Corps because increased airplane performance can be accomplished by the use of a lamp assembly using a three-candlepower, $T\text{-}3^{1}/_{4}$ miniature bayonet-base lamp.

The change from the two-unit wing-tip lights previously used by the Air Corps, which did not meet the Civil Aeronautics Administration requirements, to the single-unit wing-tip light was due to less aerodynamic drag of the one-lamp unit. This reduction in aerodynamic drag is increasingly important with the present and future type airplanes due to increasing speed and performance. The use of wing-tip lights to conform to the light-intensity requirements of the Civil Aeronautics Administration made possible the elimination of the passing or auxiliary position-lamp assembly, which consisted of a 50-candlepower lamp mounted in a four-inch-diameter parabolic reflector with a red cover glass.

Formation Lights. Formation lights are used by the Air Corps to permit formation flying of tactical airplanes and to permit the extinguishing of the airplane wing-tip and tail lights. The formation lights are located on top of the fuselage and wing surface to eliminate observance of the airplanes by ground personnel. To eliminate aerodynamic drag, the flush-type lamp assembly was developed using a three-candlepower, $T\text{-}3^{1}/_{4}$ miniature-bayonet-base lamp with a shallow reflector and a suitable lens to project the light beam to the rear of the airplane. The formation lamp circuit is controlled by a dimming rheostat with an incorporated "off" position switch. The formation-lamp assembly uses a blue lens to reduce the visibility of the light signal to be seen by the trailing airplanes of a formation flight.

Essential substance of a paper presented at the AIEE Middle Eastern District meeting, Cincinnati, Ohio, October 9–11, 1940.

A. D. Dircksen is assistant electrical engineer, United States War Department, Air Corps, Materiel Division, Wright Field, Dayton, Ohio.

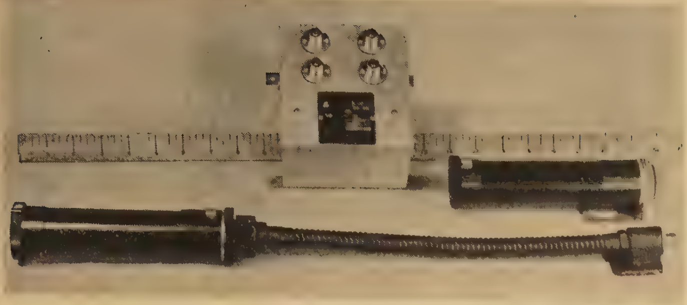


Figure 7. The inverter (above) changes airplane battery voltage (d-c) to 110-volt alternating current as required by the fixed fluorescent lamp assembly (right center) and the flexible lamp assembly (below)

Intensity of the ultraviolet radiation is regulated by the end knobs, visible light can be obtained by opening an aperture

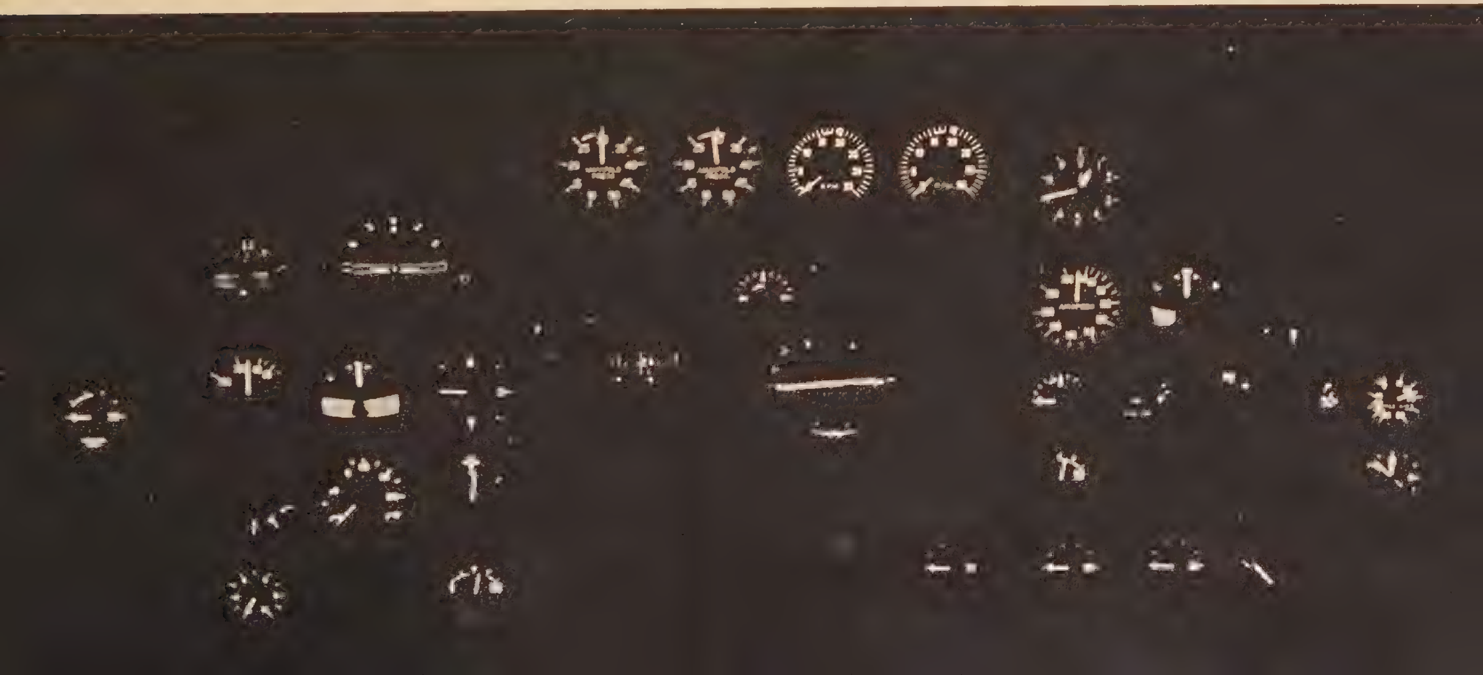
Cabin Lights (Dome and Worktable). A new type of dome light recently was standardized by the Air Corps which uses a 21-candlepower silver-tipped light-shielded lamp. This lamp assembly is used in the airplane where no gasoline vapor will be present. In locations where gasoline vapor may be present a vaportight dome light will be used. This vaportight-lamp assembly uses an impact resisting coverglass and is suitably gasketed to render the unit vaportight. A worktable lamp assembly with a flexible arm is used for the navigator's plotting table. Development is being made on a lamp assembly using the new six-watt, nine-inch-long daylight fluorescent lamp. This lamp assembly will have incorporated in the base a 400-cycle reactor, lamp starting switch, and the control switch for the lamp circuit. This type of lamp assembly has been fabricated and tested and is being standardized by the Air Corps.

Indicator Lamps. Indicator lamps are used throughout the airplane for indicating fuel pressure, oil pressure, radio marker beam, camera operation, bomb release, etc. In the event that more than three signal-lamp assemblies are required, a common box housing the signal lamps is used. The box is provided with plastic light-transmitting nameplates which are painted with black enamel and then engraved and placed adjacent to their corresponding signal lamps. This provides suitable identification of the signal lamps, which is necessary because of the restriction of the number of colors of the color code. The test switch which is provided in this box permits checking of the lamps prior to and during flight. The use of the test switch eliminates the use of duplicate lamps in the circuit and is needed for safety purposes. In the event that three or less signal lamps are used, a shielded lamp assembly, using the three-candlepower T-3$^1/_4$ miniature-bayonet-base lamp and a suitable colored lamp cap is used.

Bomb-Release Signal-Lamp Assembly. A bomb-release signal light is used to permit formation bombing. The lamp assembly consists of two 100-candlepower lamps in reflectors and is located to project the light beam to the rear for signals to the trailing airplanes. One lamp and reflector giving a white signal is used to indicate the opening of the bomb-bay door. The other lamp with reflector is provided with a red cover glass which indicates the time of the release of the bomb. Because of the short duration of the current in the bomb-release solenoid, in which this lamp is connected, it is necessary to use a time-delay relay to provide a red-light signal of approximately three seconds.

Inter-Aircraft Control-Lamp Assemblies. Inter-aircraft control lights are used for communication between airplanes in formation in the event that the use of radio communication is not permissible. The assembly recently standardized by the Air Corps is a magnetically operated shutter type which intercepts the light between the lamp and the reflector. A signal is emitted when the coil is energized which pulls the light shutter from between the lamp and the reflector. This lamp assembly is approximately six inches in diameter and uses a 100-watt medium-prefocused-base lamp. The lamp assembly is hand-

Figure 8. With the fluorescent instrument-lighting system used in the Air Corps, only the luminous markings on the dials are visible inside the cockpit at night



operated and messages are sent by Morse or predetermined code.

Instrument Lighting. The Air Corps has recently standardized on fluorescent instrument lighting. This type of lighting employs the method of floodlighting the instrument panel with near ultraviolet light to increase the activation of the luminous material and to activate the fluorescent identification, range markers, and intermediate scale divisions. It is necessary that the lamp assembly be installed between the pilot and the instrument panel and so arranged as to floodlight the instruments uniformly with near ultraviolet light.

The fluorescent lamp assemblies, as standardized by the Air Corps, use the new four-watt six-inch T-6$\times$2$^1/_2$ flat-bulb blue fluorescent lamp and a Corning 586 ultraviolet-light filter glass. This lamp assembly transmits near ultraviolet rays which activate the fluorescent and radioactive material. The fluorescent instrument lighting system which was developed at the Materiel Division, consists of the types A-8 and C-1 cockpit lamp assemblies which are the fixed mount and flexible arm types, respectively, and the inverter and the lamp-reactor control box.

The inverters, as standardized, which are used on aircraft having 12- and 24-volt d-c electrical systems, are for one-, two-, and four-lamp installations. Of the vibrator type, the inverters have the lamp reactors incorporated and are also designed to supply alternating current for the three-volt signal and compass lamps. On the larger airplanes, where either a 400-cycle 110-volt auxiliary engine generator or a 400-cycle rotary inverter is used to supply power for the Autosyn indicators, automatic pilot, radio, and instrument lighting, the lamp-reactor control boxes are used in lieu of the vibrator-type inverters.

Extensive flight and laboratory tests were made on the inverters and the lamp assemblies for the fluorescent instrument-lighting system, which was so named to distinguish it from the argon system. The argon lamp emits near ultraviolet light and produces the same effect as the fluorescent instrument-light fixtures except that the ultraviolet output is considerably less than that of the fluorescent lamp. Comparative flight tests were made between the fluorescent, argon, and individual lighting systems with the results favoring the fluorescent system.

The project of instrument lighting by ultraviolet light was started by the Materiel Division approximately four years ago, but lack of suitable ultraviolet sources retarded its progress. The first flight tests were made with experimental 15-watt 18-inch blue lamps; because of the size of the lamps, they were located to the rear of the pilot. A very unsatisfactory condition resulted from this setup as the pilot's eyeballs fluoresced with the ultraviolet light that was intercepted by his eyes. The results of this test indicated the need for a small ultraviolet light source that could be controlled and located between the pilot and the instrument board and to floodlight the instrument panel uniformly.

The four- and six-watt blue fluorescent lights were developed by the lamp industry to meet these requirements. Due to a redesign of the lamp assembly, and the use of a special curved ultraviolet filter glass, only the four-watt six-inch blue fluorescent lamp was standardized. Fluorescent instrument lighting eliminates glare and reduces to a minimum the amount of light or the light level in the cockpit. This provides for improved visual acuity of the pilot between outside and inside the airplane cockpit. This is increasingly important with the present and future airplanes due to the increase in speeds and maneuverability and for formation flying. The difficulty encountered with reflections of the lighted instruments on the windshield and windows is reduced to a minimum with the reduced light level obtained by the fluorescent lighting system as against the superseded individual instrument lighting system. The type C-4 flexible cockpit-lamp assembly (spotlight type) is used for map illumination and for the auxiliary instrument-lighting system.

Empire State Lightning Studies Continued

BEGUN in 1935 under the direction of Doctor K. B. McEachron (A'14, F'37), the study of lightning strokes to the Empire State Building in New York, N. Y., has been continued by the General Electric Company. During the 1940 lightning season, the tower of this building, the top of which is some 1,240 feet above ground, was struck by lightning at least 20 times. Detailed records of these strokes were kept by P. C. Edwards (A'38) who, assisted by Mrs. Edwards, had the assignment of photographing and studying the volts striking the skyscraper during that season.

As in previous studies (*EE, Dec. '38, p. 493–505; 507*) the 1940 studies included the taking of oscillograms at the Empire State Building and photographs of the strokes with a moving film camera from the 39th floor of the building at 500 Fifth Avenue. A remote-control automatic camera on the roof of the Printing Crafts Building on Eighth Avenue provided right-angle views of the bolts hitting the Empire State structure. Records from the two buildings provide three-dimensional information concerning the bolts. During the 1935 season, 4 bolts were recorded; during the subsequent seasons the number of bolts studied were: 1936, 22; 1937, 41; 1938, 24; and 1939, only 1. The photograph reproduced here is considered to be the best one taken during the 1940 season. This bolt occurred at 9:11$^1/_4$ p.m. on August 6. Storms that night kept the couple at their instruments from early evening until 4 a.m. the next day. The duration and multiple nature of the stroke may be seen from the reproduction.

Recent Applications of Radio to the Remote Indication of Meteorological Elements

HARRY DIAMOND

Lightweight radio transmitting equipment, carried aloft by balloons, is being used to obtain remote indications of meteorological elements, from the stratosphere. Such equipment also makes possible periodic observations from unattended stations in remote locations.

IN THE past few years there has been increasing application of radio to the extension of the geographical boundaries within which routine weather observations may be made. Heretofore, weather observations were limited to those which could be obtained by human observers near the weather instruments. The use of special measuring devices which automatically translate the variations of the meteorological elements to be measured into corresponding radio signal variations has removed many of the practical limitations. Measurements may be obtained from any point where it is possible to locate the measuring and auxiliary equipment, and they may be recorded (automatically, if desired) at any convenient point within radio contact of the measuring point. Thus, upper-air observations may be obtained economically well into the stratosphere by sending aloft, attached to small balloons, meteorological instruments with associated miniature radio transmitting equipment. Also, periodic observations may be had from isolated locations such as mountain peaks, small islands, floating buoys, and the like, where unattended equipment may be serviced at infrequent intervals but where it would not be practicable to maintain an observation staff. The government's meteorological services are already making extensive use of the balloon-carried equipment (radio sondes), daily upper-air observations being obtained at a large number of land stations in continental United States, Alaska, and the Caribbean, and at shipboard stations in the Atlantic and Pacific. The use of automatic weather stations at remote isolated locations is just beginning, but already quite a number of installations are in project.

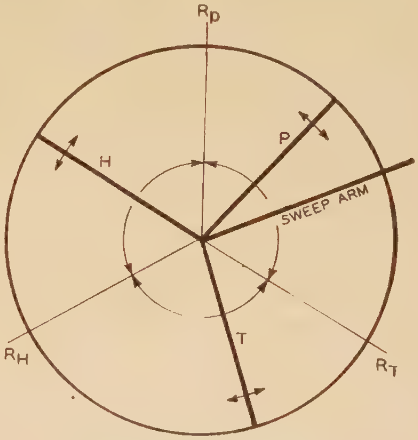
METHODS AND EQUIPMENT

Measurements required in routine upper-air observations include: barometric pressure, air temperature, relative humidity, and wind velocity, all as a function of altitude. Altitude is determined from the air density computed on the basis of the pressure, temperature, and humidity observations. Measurements that may be required in observations at remote isolated locations include: barometric pressure, air temperature, relative humidity, surface winds, precipitation, visual range (visibility), ceiling height, amount of sky overcast, and so forth. Present-day technique has not yet provided for the remote indication of all these elements, as will be evident later from the description of equipment. However, the methods are quite general and probably capable of extension to include the elements not now measured.

The methods used are characterized primarily by the means employed for translating the response of the measuring instruments into predetermined variations of some characteristic of the radio signals, whereby remote indication is provided at the receiving station. The emitted radio wave may be keyed according to code or to time, or the frequency of the carrier wave or of a signal modulating the carrier wave may be varied. In view of the very low power developed by some of the measuring instruments, the translating means must have negligible reaction upon the measuring instruments. This requirement automatically rules out remote-control and indicating methods, used successfully in radio signaling practice, which employ special coding sequences.

Olland or Time-Cycle Method. Figure 1 shows a translating method which is applicable when the instrument response is in terms of the mechanical deflection of a pointer. This method was devised by the Dutch scientist Olland in 1872 to send along wire lines from a mountain top measurements of barometric pressure, air temperature, and relative humidity. It has formed the basis of a large number of radio-sonde designs in this country and abroad. In the simplest form, the instrument pointers are mounted concentrically, each pointer deflecting over an arc of about 120 degrees. The instruments are calibrated in terms of the angles of deflection of their pointers from zero reference positions (R_P, R_T, and R_H in figure 1). The deflection angles are measured in terms of time by a sweep arm

Figure 1. Principle of Olland method



Harry Diamond is a physicist for the National Bureau of Standards, Washington, D. C.

rotated at constant speed (1 rpm) by a clock. In moving, the sweep arm makes contact with distinctive index markers corresponding to the pointer reference positions and with wipers carried by the pointers. These contacts may be made to key the radio transmitter on or off, so that the elapsed time between the occurrence of a keying pulse corresponding to a reference contact and that corresponding to a pointer contact serves as a measure of the angle of deflection of the particular instrument pointer.

As described, the method is subject to two serious disadvantages in radio-sonde application: (*a*) the pulsating angular motion of the second hand (two beats per second in the average inexpensive clock) results in coarse subdivision of the deflecting scale (three-degree minimum for two beats per second) so that there is insufficient measuring accuracy; and (*b*) the average inexpensive clock is unsuitable for operation at the low ambient temperatures encountered in the stratosphere.

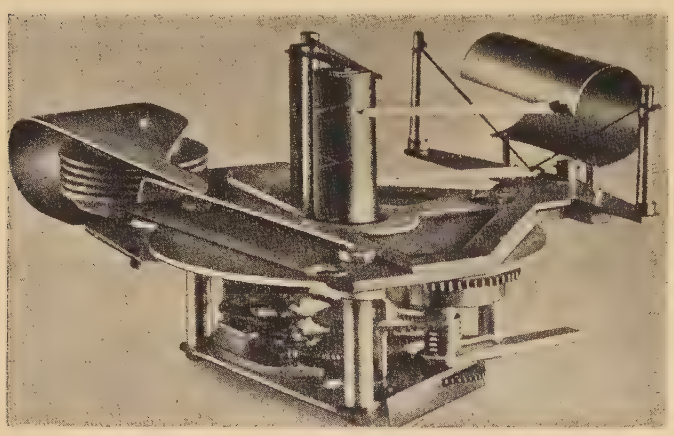


Figure 2. Radio sonde of Blue Hill (Mass.) Observatory using three-turn clock-driven spiral for dividing the pointer scales

These defects have been overcome in a variety of ways by different experimenters. Only a few of the outstanding modifications will be described here. Lange[1] employs a rotating cylinder driven by a clock, a three-turn spiral contactor wound on the cylinder forming the means for dividing the deflecting scales of the pointers into angular units which may be measured in terms of time (see figure 2). The pointers deflect along arcs that are substantially parallel to the axis of the cylinder, a single index marker at one end of the cylinder serving as the zero reference marker for all three pointers. It will be evident that each turn of the three-turn spiral will subdivide only one-third of the possible arc of deflection of each pointer; hence, three revolutions of the cylinder will be required for subdividing the complete deflection arc. Thus, the unit of scale subdivision imposed by the pulsating angular motion of the cylinder will be only 1/360 of full-scale (for a two-beat-per-second clock) was compared to 1/40 of full-scale in figure 1. Thermal insulation of the clock is used in this instrument to obviate defect (*b*).

Curtiss, Astin, Stockman and Brown,[2] have devised a miniature constant-speed d-c motor for rotating the sweep arm, thus overcoming both disadvantages simultaneously. The motor operates from a 1.5-volt penlight cell and draws only eight milliamperes.

Major Bureau,[3] in France, adopted a somewhat different method for eliminating the clock. He employs a spring motor for driving the sweep arm and, at higher speed, a toothed disk. The teeth pass successively between the plates of a capacitor, thereby modulating the radio transmitter (by detuning). The angle of deflection of an instrument pointer from its zero reference position is thus measured directly in terms of the number of cycles of modulation occurring between the reference and pointer contacts. The disk has nine teeth with a gap in place of a tenth, thereby facilitating the count of the modulation cycles at the ground station. This arrangement eliminates the requirement for constant-speed drive of the sweep arm.

Kenneth Whitney of Julien P. Friez and Sons Company has devised a method (unpublished) which utilizes a miniature synchronous motor for driving the sweep arm. An audio oscillator, utilizing a special transformer, provides voltage of substantially constant frequency for driving the synchronous motor and also for modulating the carrier wave of the radio transmitter. Voltage of the modulation frequency, after detection and amplification at the receiving station, is used for driving a recorder drum in exact synchronism with the sweep arm on the balloon. The recorder scale may therefore be graduated in terms of the deflection arcs of the instrument pointers.

Carrier-Frequency Variation Method. Figure 3 shows the electric circuit arrangement of a radio sonde based on a method devised by Väisälä[4] and on modifications introduced by H. Dahl, O. Dahl, and M. Jenssen.[5] The three variable capacitors *B*, *T*, and *H*, controlled respectively by the pressure, temperature, and humidity instruments, and the fixed capacitor *N* are connected successively in parallel with the tuning capacitor of the radio transmitter by means of the motor-driven switch *R* (1,500 rpm). The successive

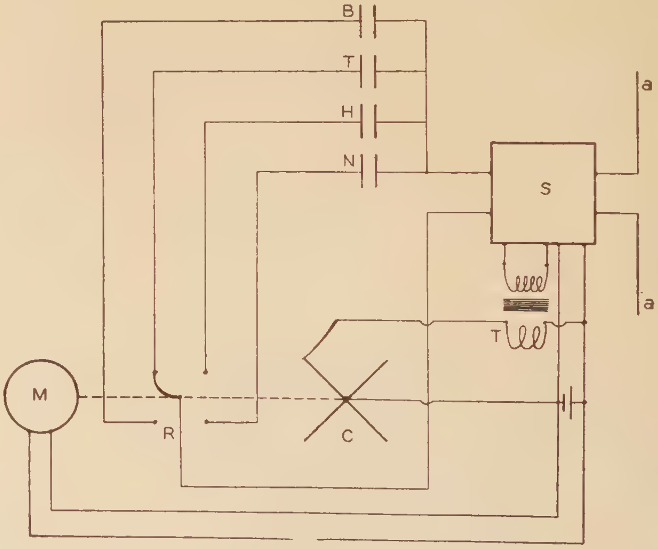


Figure 3. Circuit arrangement of the Norwegian radio sonde

values of the carrier frequency thus provide means for evaluating the responses of the measuring instruments, the fixed frequency serving as a check on the transmitter performance. The range of frequency variation used is approximately ten per cent of the carrier frequency (that is, 2.5 megacycles at 25 megacycles).

Rotating synchronously with the switch *R* is a four-contact switch *C* which serves to interrupt the direct current through the primary winding of transformer *T* at exactly the instant when *R* connects one of the capacitors into circuit. A high-voltage pulse is thus applied to the transmitter (on the secondary side) which is sufficient for operating the transmitter for a short interval. This method limits the battery needed in the radio sonde to a single low-voltage cell.

The receiving and recording arrangement used is shown in figure 4. The receiver-tuning range is traversed slowly (twice per minute) by means of a motor-driven cam. The recorder pen moves across a paper chart synchronously with the tuning control. A relay operates the pen whenever the frequency of the receiver corresponds to one of the four frequencies of the radio sonde.

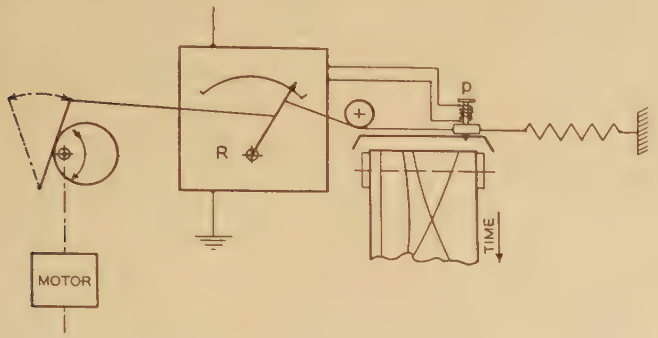


Figure 4. Receiving and recording equipment for Norwegian radio sonde

Modulation-Frequency Variation Method. A radio sonde that employs variation of the modulating frequency as the means for translating the response of the measuring instruments[6,7] is in present widespread use by United States Government agencies. The audio oscillator is of a special kind, such that the generated frequency is controlled by the value of resistance connected in its grid circuit. Hence, the measuring instruments may be of conventional types mechanically controlling variable resistors, or of special types designed to vary inherently in electric resistance in response to variations in the meteorological elements which they measure.

The capillary electrolytic thermometer and the electric hygrometer are of the latter class. The former utilizes the effect of temperature on the conduction of electricity through an electrolyte; the latter is based on the effect of moisture on the conductivity of a hygroscopic salt. The two units are connected alternately into circuit by a relay controlled by the pressure-measuring instrument. Pressure measurements are based on an actual count of the switching operations, this count being facilitated by the connection of fixed index resistors into the circuit at predetermined pressure levels.

The audio-modulation type of radio sonde affords several distinct advantages over other types. The need for a clock or motor is eliminated. The electric instruments may be controlled in manufacture to give predetermined characteristics, thereby reducing the amount of calibration required, and hence the cost. The electric instruments may be designed for very rapid response; this is of particular significance in the case of the electric hygrometer since the corresponding mechanical instrument is very sluggish. Finally, the reliance on mechanical contacts is limited to the pressure instrument only. A disadvantage of the audio-modulation radio sonde is the rather costly frequency-measuring and recording equipment required at the receiving station.

AUTOMATIC WEATHER STATION

All the methods described in the preceding section are applicable to the automatic weather station, provided that the variations of the meteorological elements to be measured can be converted into instrument responses of the required nature. The ideal automatic weather station would be one in which a minimum amount of modification of standard meteorological instruments is required to adapt them to the translating and transmitting means.

A setup that employs the Olland principle has been developed by K. O. Lange, C. B. Pear, and T. Dickey.[8] A six-volt electric clock drives a cylinder with a contact helix, turning it once per hour. During the first half of this interval, signals are transmitted for eight wind directions, wind velocity, sunshine, pressure, temperature and humidity; in addition, there are four reference contacts. The clock movement turns on the filament current of the 125-megacycle transmitter for one-half hour out of each hour and the contacts of the various meteorological instruments switch the plate battery into the circuit. The transmitter is operated by dry cells.

The reception is the same as with the Olland type of radio sonde, employing a chronograph recorder. A carriage moves down and up along a drum in the course of one hour. The graph is made on the way down, since all signals occur only during the first half-hour out of each hour. A special relay mechanism synchronizes the recorder with the automatic weather station at the beginning of each cycle.

Figure 5 shows the electric-circuit arrangement of an automatic weather station[9] in which some progress has been made toward the use of standard instruments. The method of remote indication used is identical with that employed in the audio-modulation type of radio sonde. The variation in a meteorological element is converted into a change in electrical resistance which in turn produces a change in rate of keying the emitted carrier wave. Very low keying frequencies are used, ranging from 0.15 to 3 cycles per second. The low frequencies allow direct keying of the radio transmitter and the use of simple equipment for frequency measurement at the receiving end. In fact, all that is required in the usual case is a stop watch and head phones.

The translation of resistance variations into corresponding variations of keying frequency is accomplished by means of a keying oscillator of trigger type. The circuit arrangement is shown in figure 5. The oscillatory circuit $L_1C_1L_2$ is tuned to a frequency of about 1 megacycle per second. The 1-megacycle oscillations are interrupted at a rate determined by the time constant of the resistance-capacitance combination in the grid circuit. Here, R is the variable instrument resistor (generally in series with a limiting reference resistor of about 40,000 ohms) and C is a stable capacitor of about eight microfarads capacitance. The output of the keying oscillator is coupled to a half-wave rectifier which, in turn, applies negative voltage to the input of the relay control tube. The smoothing filter R_2C_2 in the plate circuit of the keying oscillator converts the groups of 1-megacycle oscillations into corresponding pulses. After rectification, these appear as negative pulses on the grid of the relay-control tube; their duration is controlled by the time constant of the network R_3C_3. The relay is normally in the actuated position; the armature is released upon application of the negative pulses to the grid of the relay-control tube and remains open so long as the grid bias is sufficient to keep the current through the relay coil below the "pull-in" value. The back contact of the relay thus may be used for keying any conventional radiotelegraph transmitter; there is seen to be no limitation on the power output of the transmitter. In figure 5, the keying relay is in parallel with the key of a conventional radiotelegraph transmitter.

The pressure, humidity, and rain-gauge instruments are of standard design, the rain gauge being of the weighing type. In each instrument, a relay-operated clamping bar is added for clamping the instrument pointer against the edge of a wire-wound resistor when an observation from that instrument is desired; this provides the means for converting the instrument deflection into variable resistance. The instrument pointer is allowed to swing freely except when an observation is made, thereby limiting friction to that normally present in the standard instrument.

The temperature element consists of a glass capillary tube filled with an electrolyte having a high temperature coefficient of electrical resistance; the resistance of this device is thus a function of the ambient temperature. This arrangement is the same as that in the audio-modulation type of radio sonde except that a tube of greater life is used.

The wind-direction indicator (of standard type) has eight 45-degree contact segments corresponding to the eight principal compass points. A different fixed resistor is connected to each segment and thrown into circuit when the wind vane assumes that direction. Directions intermediate to any two principal directions are indicated by taking advantage of the oscillation of the wind vane about its average position; such oscillation tends to connect into circuit successively, on a proportional basis, the two resistors corresponding to the adjacent principal directions. The average value of the resultant keying frequency thus lies between the values for the two principal directions considered.

The wind-velocity indicator is a standard commercial cup anemometer with the "take-off" contacts stepped up by a factor of four, so that four contacts per minute correspond to one knot. These contacts are made to key the radio transmitter directly.

Simple automatic control equipment operates to allow a warm-up period for the transmitter after starting, then to send out the station call letters, a reference frequency, and finally the several observation frequencies corresponding to the desired measurements each preceded by an identifying code. The sequence is carried out by means of

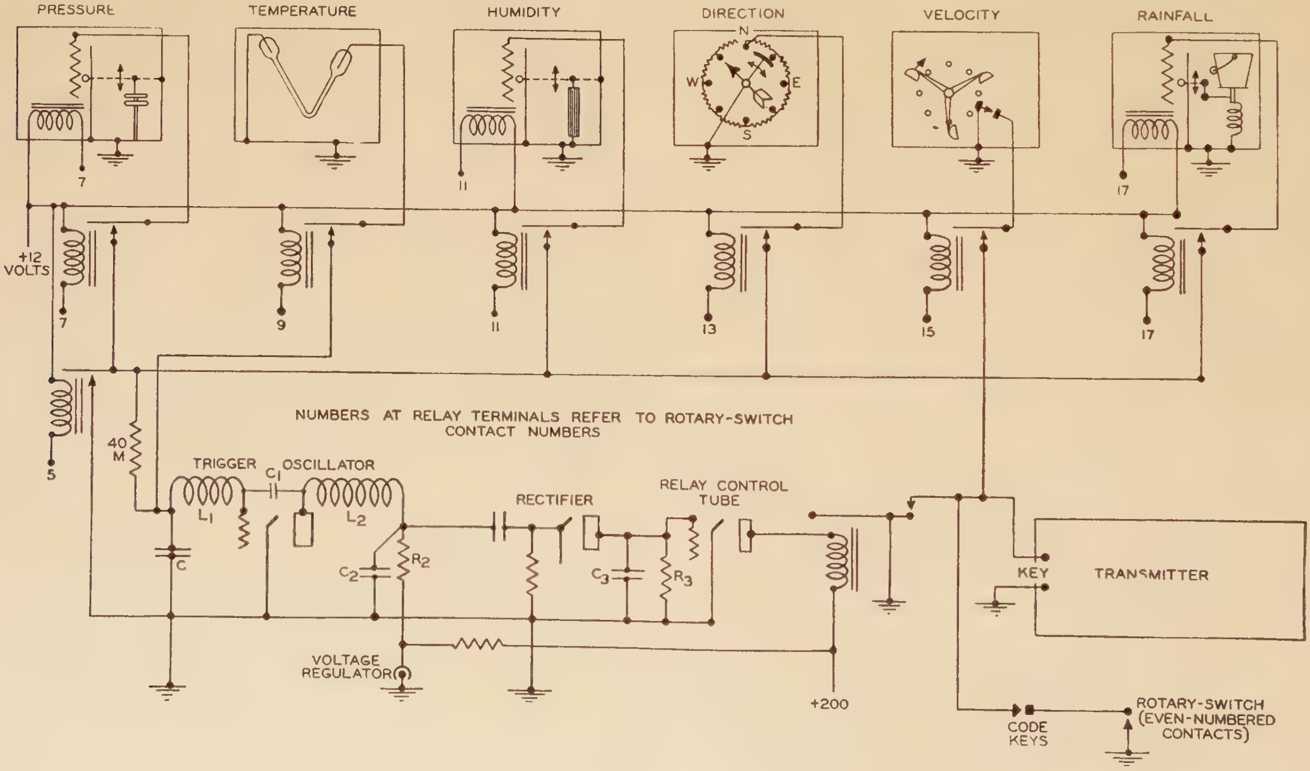


Figure 5. Circuit arrangement of automatic weather station

an automatic rotary switch, certain odd-numbered contacts of which operate the relays shown in figure 5 which are given corresponding numbers. Certain even-numbered contacts of the rotary switch connect coding circuits (formed by code disks and associated switches) in parallel with the keying relay to key the transmitter in accordance with the station call letters at the beginning of a sequence and with the code letters *P*, *T*, *H*, *D*, *V*, and *R* preceding the observations of pressure, temperature, humidity, wind direction, wind velocity, and rainfall, respectively. The whole sequence is started by a clock at preset times of day, and is repeated twice for convenience.

The functions of the various relays associated with the odd-numbered contacts of the automatic rotary switch are evident from figure 5. Relay 5 connects only the 40,000-ohm reference resistor in the grid circuit of the modulating oscillator, thereby providing a reference frequency, nominally 3.0 pulses per second; this frequency serves as a check on frequency drift of the oscillator and as a means for correcting the various observations (except wind velocity) for frequency drift. Relays 7, 11, and 17 connect the corresponding instrument resistors in series with the reference resistor; companion relays operate the clamping bars for these instruments. Relay 9 connects in the temperature resistor directly, leaving the reference resistor out of circuit; this provides for increased sensitivity of indication at the higher temperatures. The functions of relays 13 and 15 used with the wind-indicating instruments are self-evident. The contact switch in the wind velocity indicator is connected in parallel with the keying relay and keys the transmitter directly.

An experimental automatic weather station of this type installed at the Naval Air Station, Anacostia, D. C., is shown in figure 6. The top compartment takes the form of the conventional ventilated shelter for housing the temperature- and humidity-measuring elements. The wind vane and cup anemometer are mounted on the top of this housing. The middle compartment houses the control and keying unit. The lower compartment houses the radio transmitter (15 watts, 3,295 and 5,072.5 kilocycles), power supply including a storage battery and dynamotor, and the timing clock.

In conclusion, it is of interest to focus attention on the measurements desired in the radio-sonde and automatic-weather-station services that have not been provided by the equipment described. As already indicated, the radio sonde should provide measurements of upper-air wind speeds and directions. This information may be obtained by tracking the path of the radio-sonde balloon as it is carried away from the observing station by the winds. Radio direction-finding methods may be applied for determining the azimuthal and elevation angles of the balloon, using the emission from the radio-sonde transmitter. These angles, together with information on the corresponding altitudes of the balloon would be sufficient for computing the successive balloon positions. Unfortunately, the precision of determination of angles required (of the order of 0.1 degree) is considerably greater than is obtainable in the present state of the art. Some work in this direction has been done by L. C. Yuan and S. S. Mackeown.[10]

Similarly, the automatic weather station should provide measurements of visual range (visibility), ceiling height, amount of sky overcast, and the like. It is evident that such measurements will require the use of photoelectric tubes. These are devices the electrical resistances of which vary with their illumination, and which thus can be incorporated readily in the circuits described in figure 5. However, the methods of measurement to be employed have not as yet been determined.

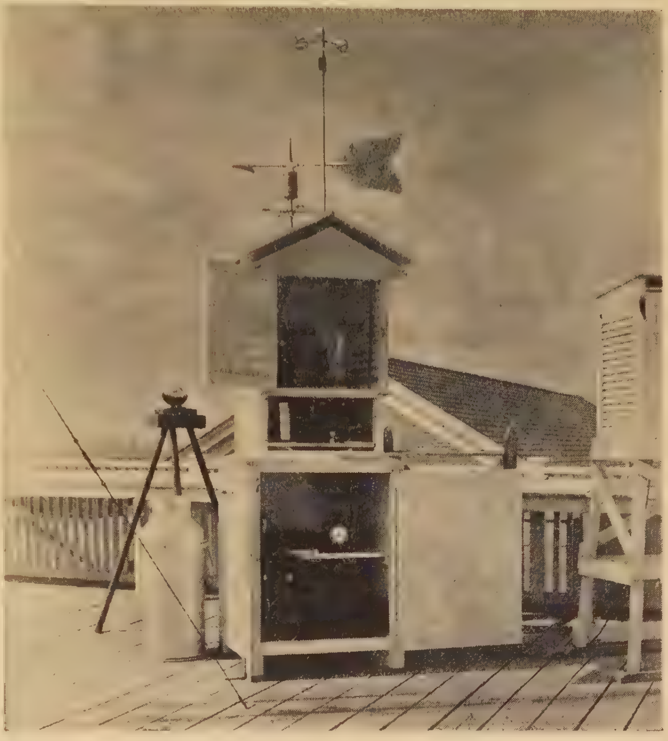


Figure 6. Experimental automatic weather station installed at Naval Air Station, Anacostia, D. C.

REFERENCES

1. The 1935 Radio Meteorograph of Blue Hill Observatory, **K. O. Lange.** *Bulletin of American Meteorological Society*, volume 17, 1936, pages 136–47.

2. An Improved Radio Meteorograph on the Olland Principle, **L. F. Curtiss, A. V. Astin, L. L. Stockman, B. W. Brown.** *Journal of Research*, National Bureau of Standards, volume 22, 1939, pages 97–103 (RP1169).

3. Les Radiosondages Météorologiques, **R. Bureau.** *L'Onde Electrique*, volume 14, 1935, pages 10–26, 87–96.

4. Eine Neue Radiosonde, **Vilho Väisälä.** *Mitt. Meteorol. Inst.*, University of Helsingfors, volume 35, 1937, pages 1–28.

5. The Norwegian Meteorological Radio Sonde, **Helmer Dahl, Odd Dahl, Matz Jensen.** *Chr. Michelsens. Inst. for Vid. og. Ando*, Beretninger IX, 1939, No. 5, pages 3–24.

6. Upper-Air Weather Soundings by Radio, **H. Diamond, W. S. Hinman, Jr., F. W. Dunmore, E. G. Lapham.** AIEE Transactions, volume 59, 1940 (June section), pages 321–8.

7. An Improved Radio Sonde and Its Performance, **H. Diamond, W. S. Hinman, Jr., F. W. Dunmore, E. G. Lapham.** *Journal of Research*, National Bureau of Standards, volume 25, 1940, pages 327–67 (RP1329).

8. An Automatic Radio Weather Station, **K. O. Lange, C. B. Pear, T. A. Dickey.** *Bulletin*, American Meteorological Society, volume 21, 1940, pages 76–7.

9. An Automatic Weather Station, **H. Diamond, W. S. Hinman, Jr.** *Journal of Research*, National Bureau of Standards, volume 25, 1940, pages 133–48 (RP-1318).

10. Radio Direction-Finding for Meteorological Balloons at 1.67 Meters, **L. C. Yuan, S. S. Mackeown.** *Proceedings*, Institute of Radio Engineers, volume 28, 1940, page 286.

The Technology of Motion Pictures

DOUGLAS SHEARER

An outline of some of the technical problems involved in the production of modern sound motion pictures

ANY GRAPHIC ART seems to involve an element of the dimension of time. For example, printing allows us to review in our imagination the happenings of previous times or the prediction of future happenings; paintings indicate to us things that happened in the past, and to happen in the future; likewise sculpture seems to contain that "mysterious" element of either preserving or reproducing happenings in time.

In the motion picture, which may be called a graphic art, certainly the element of time is more intimately involved than in any of the other three arts mentioned. A reel of film may contain pictures of the dead villain, the live villain, and the unborn villain; it contains the beginning and the end; and that is all contained in that one reel of film at that very same time. In that reel of film those things have happened or they are going to happen. You can make it go backward or frontward. You can cut out a piece in the middle; you can stick it together and have that which happened previously happen today and then show the retrospect. You can delay the action and shift it further along in the story. You can take the element of time and just move it anywhere you wish.

Time without geographic solidity and actual physical body would be as listless as physical body would be without time, so in the motion picture we have to put something tangible on the screen. We have to make an entertainment out of it. I believe the question of appeal of motion pictures to the general public is based on two main factors: One might be called the "mysterious" element of time involvement, and the other the presentation of realistic geographic records. That is, when you see a motion picture you feel that you are seeing something that either did happen, or could happen if it is a good one.

The public insists on realism in motion pictures. When we compare motion pictures to the legitimate stage we do not see the same amount of realism. If on a conventional, legitimate stage an actor goes out a door and the walls shake back and forth—well, that is not especially annoying. It is just an event you expect to occur. However, if you were to see the walls shaking back and forth in a motion picture when someone walks out a door it would disturb your sense of realism.

In the old days of pictures when a railroad train came tearing down the track many thought that this was a real happening. In the original pictures they did film actual happenings to a large extent. They enacted the complete physical events in front of the camera. That was largely due to lack of having developed technique. In the developing of this technique there have been engineering developments. Engineers have come to the business, although some of them may not be recognized as engineers. One man in the business is called the art director, but he is actually a motion-picture engineer. An art director is usually thought of as an artist drawing sketches or building sets in architecture. Actually, the art director is the man who takes the written script and puts it into physical accomplishment. He does the things that the script calls for. It might be a hurricane, it might be an earthquake scene, or it might be a ship wrecked at sea. It might be something that is not associated with art whatsoever in any sense of the word. This art director, for instance, must visualize whether we can invent a wave machine that will play tons of water on the deck of a boat at sea in the studios; he must be able to have a forest fire take place; he must build sets with openings where light can be introduced; he must have the sets arranged so that the geography of the picture can be brought about from the movements of the camera and also the microphone.

The question of engineering in the picture business has changed from going out and photographing real objects and real happenings to creating these things in a sense. Again we utilize in the picture business more and more of the time-control elements. We can shoot one scene ahead of another. We can take the front part of the story last. We can make a whole set of pictures by using a little retake and then inserting it in sequence. The technique from an engineering standpoint is real. We have more and more freedom in the handling of climaxes in order to produce consecutive impressions upon the audience.

"GEOGRAPHY" OF SCENES

Unknown to most audiences we have to resort to a little trickery every time we show them something new on the screen. We have to give them the geography of the set. That is usually accomplished by showing a "long shot." That is, a set or house, or whatever the scene is, must be firmly implanted upon the audience's mind as to the geography. The kitchen must be on the right hand or the dining room on the left hand or the parlor here or the stairway going upstairs over in that direction, and so forth. After we have shown the audience exactly how this set lies we can move in for closer shots. If we keep our actors moving in the right directions, the audience will notice that they are going to the

---

Essential substance of an address delivered at the AIEE Pacific Coast convention, Los Angeles, Calif., August 27–31, 1940.

Douglas Shearer is sound director, Metro-Goldwyn-Mayer Studios, Culver City, Calif.

kitchen, the dining room, or upstairs, without showing any part of these rooms again. We must establish in the minds of the spectators the geography of that particular set; and once that geography is established we can shift around that set with close shots, reverse angles, or other directions.

The art director plays a part in this. The camera man becomes a dimensional engineer in that sense. He must maintain that geography in his shots. The editor who cuts the film, even apart from the dramatic presentation of the story, must keep his geography and his time exactly correct. Assume, for example, that a man is going from his home to his office. If he starts for his office and moves on the screen from left to right you must always show him going in that same direction, otherwise you might think that he had forgotten something and was returning to his home. We always show steamers going to Europe in one direction on the screen and from Europe in another, so as not to confuse the audience. We want to keep the geography straight. We want to keep it simple and in that way the spectators can follow the story without having to solve the problems of the mechanical part of the picture. If a person is walking toward the camera in one part of his trip from home to the office then he must pass the camera on the correct side even coming toward it from a very small angle. Those are just some of the little dimensional geographic aspects of motion pictures that people do not ordinarily think about.

PROCEDURE IN MAKING A PICTURE

The procedure of making a picture starts with the man we call the producer. He is supposed to select a story that is suitable, and he also tries to select the cast and the crew. He is the man who decides whether a certain amount of money should be spent on a given story in an attempt to make a picture out of it that will bring back the original investment plus, we hope, some profit. By the way, if we just get our money back on an average picture we think we have done pretty well; our profits come principally from the outstanding pictures.

After a story has been procured, it is given to a screen playwright, who rewrites it in terms that can be couched in the medium of the screen. The playwright must cut the story down to be shown in the minimum time that can be allowed for that picture. A legitimate play may take $2^1/_2$ hours to run, but we have to condense the motion picture into an hour or $1^1/_2$ hours, or possibly even 40 minutes. That takes a special kind of writing. The playwright must visualize this picture as presented on the screen.

After the playwright has rewritten the play, it is turned over to a director to make the picture. This director has the aid of a casting director who selects, preferably from our own staff, the cast of characters. This staff is an investment that we have and which we have developed; in fact, it is the chief capital asset of the picture. The director is then assigned a crew. The crew consists of the art director, the electricians, certain mechanical people, the sound recordist, the assistant director, and the manager for that group. These people all take their parts in the various parts of the picture. The assistant director breaks the story down into the actual sets and scenes that have to be made in conjunction with the art director; that is, the art director's work is laid out.

Most people that are employed for a picture are used right at the start, all the scenes requiring a large cast being shot at the beginning. As we come to the end of a picture we find that we are winding up with only two or three people out of the original group that was engaged. That is necessary for several reasons. In the first place it is more economical. Secondly, if we use a man in the early part of the picture and then have him wait until two weeks later it would hold up his activities for any other picture; also we would run the risk of his becoming ill and holding up the picture completely.

When the director actually begins to make a scene he may make changes according to his view of the situation at the moment, but generally he follows the script. He has to choose the people to fit the characters of the story. He must see that all members of the cast act their characters in all the scenes throughout the story. That is the director's function. He must make his people live, interesting characters. The degree to which he does that has a great effect on producing either a drab, uninteresting picture or one where every scene is interesting, the whole picture is interesting, and it is a success.

Getting back to a little bit more of the physical side, I must not leave out the editor. The editor may be the producer with a physical assistant doing all the actual film cutting and then matching them together in their proper story relations. These scenes must be associated so that they form the right impression. When that cutting is done the picture is taken out and tried on an audience at a preview. That tryout is a test for us, not the audience. We really make them work for us. One can become quite expert in feeling the reactions of audiences without even having them say anything. We sense their reactions at the preview. We then go back and re-edit the picture. We do not necessarily have to make some of the scenes over. We can do wonders just by editing the picture and speeding it up, or eliminating objectionable scenes.

ELECTRICITY USED FOR LIGHTING

Some figures on the electricity used for lighting the scenes may be of interest. We had one of our biggest sets in the making of "The Wizard of Oz." On that set we used 40,000 amperes of direct current at 120 volts. That is a lot of amperes all going into light; in fact, we were overloading all of our equipment. We could hold that load for only about four minutes at a time. We had all of our own equipment and a lot of rented equipment on the set. This 40,000 amperes at 120 volts raised the temperature of the stage at the rate of some ten degrees a minute, even with the ventilating system operating at full load—90 cubic feet of air per minute and 150 tons of refrigeration. To supply the direct current we used five 500-kw, five 400-kw, and four 300-kw motor generators.

The annual consumption of purchased electric energy of the Metro-Goldwyn-Mayer Studios is 21,000,000 kilowatt-hours. We buy this energy at a rate that would not make it possible to generate our own, and at the same time take the risk of interruption in service. Our energy comes to us from a great network. We could not possibly depend on any plant of our own, and we could not afford to have a standby plant to take care of any emergency. Our annual cost of electric energy is $150,000.

By the use of synchronous-motor drive for our motor generators, we have a power factor of 0.95. As to lamps and lighting equipment, we have 140 150-ampere arcs, 54 120-ampere arcs, and 80 40-ampere arcs. In incandescent lighting equipment we have about 900 5-kw lamps and 67 3.2-kw units.

DEVELOPMENT OF SOUND PICTURE

Getting back to the picture itself, and particularly sound pictures, many people have asked: "Who developed the sound picture?" I have always said that the real invention was silent pictures because when the motion picture was first developed, and it happened subsequent to the phonograph, it was unquestionably Edison's intention to have motion pictures accompanied by the sound of the phonograph. The real discovery was brought about by the physical inability to present a good sound picture, that is, a purely mechanical recording and recreation of sound either in synchronization with the picture or with adequate volume and fidelity. Then somebody got the idea that perhaps motion pictures without sound might work. They then found that motion pictures without sound would entertain, so the real discovery was silent pictures.

The technique in those days was entirely different from that of present sound pictures. The time element was even more free. The entire pattern of the story could be changed by merely inserting a title. We had a great scope in what we called "mugging." In that way actors put over extremely broad expressions with their faces and their gestures. The editorial and cutting aspects were entirely different from what they are today. Silent pictures reached a certain point where the imaginative ability of the audience was even more free than it is now.

When we come to sound pictures we come closer to reality. We had to make people actually say what we wanted them to say. We narrowed that imaginative border and tied things right down to facts. Naturally, that produced a bit of chaos in the picture business; it also produced some chaos in the audience. A further move in the direction of realism is the present movement toward color. We find that in looking at black-and-white pictures there is no imaginative problem, but with color the mind goes around the frame line—there is a tendency for one to believe only what he sees on the screen; one loses all of the ability to retain imaginative value.

The coming of sound to pictures followed the development of the vacuum tube and the ability to amplify. It was not until telegraphy reached the point of becoming a means of communication and the radio field made reliable amplifiers that there was any possibility of reviving sound pictures. After that operation, a second step took place which was very important. That was the work done with electrical phonograph recordings. The complete technique of electrical phonograph recording was developed before sound pictures again were considered, at least seriously. When that had been done there remained at least mechanically only one phase. That was the simple step of synchronization, the turning of the disks with the running of the motion-picture machines; that involved many problems.

The next problem concerned the theaters. We had to equip 18,000 theaters before we could have an outlet. That was a gigantic feat to accomplish in the time that it had to be done. Great credit is due the staffs of engineers and the manufacturing groups of the electrical companies who undertook that work.

We also had our problems in the studio. Our actors and actresses were naturally completely at a loss as to what to do with sound. The stage actors also had their troubles because stage acting is so broad in its presentation. The stage actors looked rather silly because they were used to seeing overdone action, and the silent-picture people, of course, were not broad enough. There were not only certain personnel difficulties in the acting business, but there were the technical problems of making sound pictures. We had to use microphones at distances which formerly were not used in broadcast work. That is, we had to get to the point where we could have the people walking many feet away from the microphone and not particularly paying attention to where they walked.

Now we will see what some of the electrical problems were. The output, for instance, from a conventional microphone from a person several feet away talking in an ordinary tone of voice is 10 or 12 decibels below an energy level of 19×10^{-11} watt. All of the recording circuits had to be run around the stage, and the lights and the people introduced enormous pickup problems. It was almost impossible to eliminate the noise pickup.

Our channels were generally capable of amplifying the initial signal 120 decibels, or a trillionfold. We do not use all of that; we reserve about 40 decibels for control purposes. After being amplified we put it on the film in the form of a permanent record. Then the signal comes off that film onto a photoelectric cell and is amplified about a trillion times before it gets to the loud-speakers in the theaters. Thus the initial signal is amplified a trillion times twice before it reaches the audience. To preserve the plainness of the signals and to free the system from noise taxed the art of modern communication to the limit.

I believe that sound pictures require the highest ability of any telephonic effort. We know that the ordinary telephone conversation is limited in frequency band. Telegraphy, of course, has a very narrow band. Television requires a very broad band, but I believe that sound pictures demand the highest degree of fidelity. One reason for that is that we put a picture of a person on a screen, and then when the sound comes out it must sound like that person. I do not mean just like that particular individual, but it must sound human.

AN UNSOLVED PROBLEM

One of the problems of modern equipment still remaining unsolved concerns the theater systems. The usual trouble with the majority of theater systems today is that they have insufficient undistorted wattage. Many have much less wattage than a good home radio receiving set. At the studios, we have an auditorium that is only 60 feet long, 50 feet wide, and 20 feet high, but yet we believe that we need 50 watts in that room in order that there will be no distortion from the reproducing apparatus. The fact that many theaters have this low wattage limits the initial dynamic range that can be put on the film. We also limit the frequency range for other reasons. We have to break away from the theater that has an ideal situation, an extremely broad frequency band, and we have to avoid the errors that happen when we go too far. The same thing applies to the low frequencies, although that problem largely concerns the recording operation.

As to the reproduction of sound in the theater, the average engineer might think that if the sound were reproduced in its original form it would sound like the original. That does not happen. If the sound were reproduced in the average theater at precisely its original volume, possibly we could use the original frequency characteristics and reproduce it as a facsimile. However, the sound must be amplified when reproduced with the picture, particularly in the larger theaters. Because the human ear is not equally sensitive to all audible frequencies, speech sounds unnatural when amplified; this is because all frequencies over a rather wide range are amplified equally, which results in apparent increases in the volume level of certain frequencies as far as ear response is concerned. For that reason, certain frequencies in the sound record on the film must be altered so that the sound will seem natural when amplified for reproduction in the theater.

BINAURAL EFFECT LACKING

One other loss that has to be approximated at times is the loss of the two-ear properties that we all have for listening. In that respect we can analyze it just the same as eyesight. We look at a scene with one eye, and then if we look at it with the other eye we see it from an entirely different angle. We have two images really presenting two distinct pictures. In scanning those pictures we form a concept of solidity.

In sound we have the same effect in respect to our two ears. We hear the sound closest to one ear sooner than with the other ear. That presents two "pictures," one quite different from the other. When we "look" at those immediately we begin forming two images, and we form a concept which we call our hearing. That concept is one of solidity and space just as in eyesight. We can tell whether a person is far, near, at the right or left, behind, above, or below. A peculiar property of the human hearing system is the ability to switch what we in the motion-picture business call the "attention factor" without any physical motion. We can listen to a person with either ear; we can ignore the person behind; we can listen to a person across the table and ignore the rattling of dishes. This gives people the ability in their hearing to lower the sound of those things in which they are not interested and to listen to the things in which they are interested.

Some Statistics Compiled by the Academy of Motion Picture Arts and Sciences (for the Year 1937)

Total number of theaters in the United States	18,000
Total seating capacity	10,924,000
Total weekly attendance	85,000,000
Estimated gross box office receipts for year	$1,000,000,000
Tax paid to Federal Government during year	$100,000,000
Distribution of box-office receipts, per cent:	
Theater staff and management	25
Real estate	15
Advertising	8
Lights	5
Interest and dividends	5
Other taxes and miscellaneous	344
Film rental	535
Proportion to studios	25
Proportion to distributors	10
Capital invested—in U. S. theaters	$1,800,000,000
In motion picture studios	100,000,000
In distribution companies	20,000,000
Employees—Exhibitors	214,000
Studios	28,500
Distribution companies—Wholesale	12,500
Retail	241,000
Payroll for year—Exhibitors	$250,000,000
Producers	91,000,000
Distributors	26,500,000
Amount paid to "extras" during year	$3,000,000
Number extras employed	16,000
Average days worked by extras during year	18.4
Average daily wage paid to extras	$10.03
Average annual earnings of extras	$187.00
Number of feature pictures produced during year	608
Number of positive prints from each picture	250
Average number of runs per positive print	200
Number of feet of positive film produced in year	2,000,000,000
Cost of producing positive film	$20,000,000

What happens when we record that sound? A microphone is only a single-channel device. It has no means of picking up any two-way images. The microphone records the exact physical value of all sound that reaches it. This recording takes on a true physical importance and not the psychological importance. We lose the binaural or two-ear hearing ability, and then we have to try to substitute something for it.

As an example, suppose we have a group of people dancing around a floor; their feet, apparently, make more noise than we usually hear. At a dance we do not listen to that noise; we listen to what a person has to say or to the music, so we have to diminish this actual noise. If we have a bunch of people chattering in a mob scene something like this might go on: "Mr. Conway, we are having too much noise." Then Mr. Conway says: "I like it." "But," we say, "Mr. Conway, you do not hear it that way. It will be so much louder on the screen." The argument then goes on and we will finally say, "Mr. Conway, you just leave out that feet shuffling and then we can run in as much of it as we need." He just did not hear that shuffle with both ears as it would be recorded.

The question of that loss of binaural hearing is quite important in sound pictures. All noises that can be avoided in the original scene are avoided because they are usually reproduced in exaggerated importance. That is the very nature of binaural loss, which we must compensate.

SOUND AND SCENE GEOGRAPHY

We have some interesting geographical uses of sound. The geography of scenes can be tied together by handling of the sound effects. Take a simple little scene of a man leaving a lake. We will probably have to do some frequency correcting in that scene, as there were some frogs croaking in that lake. We can cut the scene to the man walking up the steps of a little cottage or house. If we carry that frog croaking over to the scene of the little house it means that the house is near the lake. Suppose we shift the next scene to an elevated train. Naturally, one would expect that to be in a large city, and would not expect the elevated train to be right near the lake. We could not have the frogs croaking in the elevated-train scene. Many of those things are not put in there to be heard, but when we do hear the frogs croaking we know that the house is near the lake. We do not have to explain how the man got to the house. That will give just a little idea of the technique of sound in pictures. We utilize that effect work to get the audience's mind on the geography, the timing of the scene, and many of those things they do not hear.

Take the case of an orchestra in a restaurant. We will show the geography of the restaurant in a long shot. The orchestra will be quite full. Two principals may walk into the scene and start to talk. We drop that orchestra way down. We have a re-recording of that low orchestra music the moment the principals start to talk. You will not even notice that the orchestra has been lowered because we have switched your attention to the two people. You do that in actual life. The attention factor of the orchestra would have dropped 30 or 40 per cent the moment you started to listen to these two people so we just dropped the orchestra the moment they uttered a word. You go right through the scene without even noticing it.

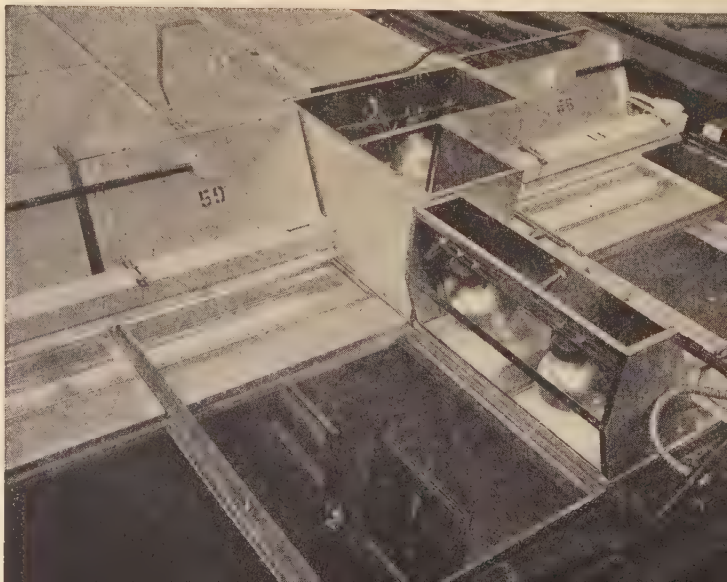
As I have gone along I realize that I have not covered the entire subject of modern motion-picture technology, but I hope that I have covered some points that will be of most interest. As to the question of people in the studio, it is usually thought that the actors are the most numerous and, of course, the most important. In our studio we have some 4,000 employees, and I think that only about 200 of those are actually actors. When the whole gang gets going down the street to get something to eat you can hardly find an actor.

Combination Lighting Designed for Art Gallery

MASTERPIECES of famous artists in the Carnegie Institute's gallery *A* in Pittsburgh, Pa., now can be seen indoors just as the artists painted them, and many people for the first time are seeing parts of famous paintings which heretofore were not discernible. This is the result of a new system of lighting specially designed by Richard C. Engelken (M'33) well-known lighting consultant, and manufactured by Westinghouse. Because oldentime artists painted under natural daylight, paintings viewed under incandescent electric lighting are not seen in their true colors, and detail in dark spaces in the paintings is not discernible. By means of a special combination of 220 incandescent and 206 fluorescent lamps, the 112-foot long gallery *A* is lighted with an illumination nearly identical with the natural daylight by which most painters produced their works.

Lighting on the paintings is approximately eight times as bright as in the center of the gallery. This creates light comparable with the most ideal condition for viewing a scene out of doors. This illumination is obtained from a completely luminous ceiling of heat-treated water-white glass, above which are mounted four continuous rows of fluorescent lighting units. The light from these lamps is mixed with that from the incandescent units, mounted above control lenses which form part of the glass ceiling, along the four walls of the gallery. To obtain correct color matching, the control lenses are treated to take advantage of the relatively small amount of blue and green emitted by incandescent lamps. By adjusting lamp angles and lenses, dark paintings have been toned up, and the brilliant ones toned down.

(Left) Mr. Engelken directs adjustment of combined fluorescent and incandescent unit; (below) light from both sources is matched and controlled by special lenses in the ceiling units



Engineering Training for National Defense in the United States

A. A. POTTER

Leaders in the engineering profession and in the Army and Navy agree that the engineering colleges of the United States should maintain strong educational programs and increase their research efforts, in addition to making special facilities available for emergency training, according to this distinguished educator and consultant on the Government's program.

THE United States of America has set out upon an armament program which has as its objective the doubling of its Navy and the quintupling of its Army, in addition to large quantities of armaments for Great Britain. All facilities are being mobilized to insure speed and efficiency in carrying out this program. It is realized that the production of modern mechanized armaments on the scale contemplated requires not only millions of people who are skilled as mechanics but also large numbers of engineers who are competent in a wide variety of technical and supervisory services. One out of every ten employees of the airplane industry must be an engineer, as 250,000 man-hours are required to design a modern military plane. It takes about 25,000 blueprints for the construction of a medium-sized tank, and a modern battleship costs $5,000,000 to $8,000,000 to design and involves drawings which weigh tons. Already an acute shortage of technical engineering talent exists in certain of the industries as well as in the Army and Navy. The airplane industry reports serious shortages in engineers who can design, test, and maintain airplanes. Needed also are thousands of additional engineers who are competent as designers of tools, dies, jigs; or in part analysis, shop layout, and cost estimates of labor and materials. Additional engineering inspectors are needed by industry as well as by the Army and Navy, with knowledge of materials, physical testing, X-ray inspection, radiographic technique, and explosives, and automotive and electric communication equipment. There is also a substantial shortage of machine designers, metallurgists, naval architects, and marine engineers. Besides the needs for technical engineering specialists, industry is confronted with a shortage of industrial engineers and engineering supervisors to speed up the production of equipment necessary to the present armament program—engineers who are familiar with industrial organization, time and motion study techniques, production control, material handling and storage, inventory, budgetary and accounting control, industrial safety, and industrial relations.

During the First World War the engineering schools of the United States were responsible for the major portion of the vocational training program for the United States Army. The vocational division of the Students' Army Training Corps was mainly concerned with the training of mechanics and little attention was given to defense training on the engineering-school level. During the past 23 years the United States Government has co-operated with the various states in the development of a nation-wide program of vocational education of less than college grade. As a result of this there are available in the United States over 1,000 public vocational schools with a plant valued at more than $1,000,000,000. The Congress of the United States of America has appropriated to the United States Office of Education for the present fiscal year, ending June 30, 1941, a total of $66,500,000 for a vocational education program of "less than college grade." This vocational education program is being administered in every state under the state board of vocational education and is carried on mainly in secondary schools and trade schools. Much of this program is concerned with supplementary evening courses for individuals now employed in industry. Pre-employment full-time courses are also administered to increase the supply of workers essential in the National Defense program. It is expected that during the present fiscal year the skills of more than 500,000 people will be increased through this vocational educational program of "less than college grade." No tuition is paid by those receiving instruction.

Engineering colleges realize that their greatest contribution to our armament program will come by undertaking the type of training for which they are best equipped, that is, training on the "engineering-school level," rather than vocational trade courses which ordinarily can be taught more effectively by trade and vocational schools. By college level is meant instruction comparable in difficulty and prerequisites with courses included in engineering curricula. The leaders in the engineering profession as well as in the Army and Navy are insistent that the engineering schools of the United States should maintain during the present emergency the strongest possible programs of undergraduate and graduate instruction and should increase their research efforts so that an adequate supply of well-trained and creative engineers is assured. It is felt, however, that many of our engineering schools have special facilities which may be utilized advantageously, without interrupting their regular programs, in making available to our defense industries and to our Army and Navy additional and more competent engineering specialists. Congress appropriated on October 9, 1940, to the United States Office of Education $9,000,000 (*EE, Dec. '40, p. 521–2; Feb. '41, p. 92–3*) to be used in reimbursing engineering schools up to June 30, 1941, for the administration of the following programs:

1. In-service training programs for the purpose of up-grading the

---

Address prepared for the annual meeting of the Engineering Institute of Canada, Hamilton, Ont., Canada.

A. A. Potter is dean of the schools of engineering, Purdue University, Lafayette, Ind., and consultant and chairman of the advisory committee to the United States Office of Education on the engineering education program for National Defense.

engineers and supervisors now employed in industry. More than 50,000 of the engineering and supervisory staffs, employed in defense industries, are now enrolled, mainly outside of working hours, in classes which meet two or more times every week. Some of these classes are in the nature of refresher courses and cover subjects ordinarily given during the first three years of an engineering college curriculum. The majority, however, are enrolled in advanced classes in design and industrial engineering. Present indications are that this in-service training program will have to be greatly extended and enlarged during the next few months. Through this type of training engineering schools are in a position to speed up the armament program and to improve the product of defense industries without interrupting their regular collegiate engineering instruction on the campus.

2. Intensive resident programs of study are being set up for the benefit of commissioned officers of the Army and Navy and for those who are interested in preparing for the specialized engineering positions now open in the defense industries or in government employ under the regulations of the United States Civil Service Commission. These intensive courses are about three months in length and are open to those who have had some formal engineering education, usually about three years, and considerable experience. As a concrete illustration: The Air Corps of the United States Army has at present 50 cadets in each of two engineering schools who are being given an intensive three-month course in aerodynamics, airplane structures, airplane power plants, and airplane instruments. The majority of these cadets are engineering college graduates and are being prepared for commissions in the Air Corps of the United States Army as squadron engineering officers. It is expected that about 600 such squadron officers will be trained during the next few months. Due to the fact that nearly all the engineering college graduates are well placed in industry, the resident intensive program is not developing as rapidly as is the in-service program. It is expected, however, that at least 10,000 will be benefitted by this program between now and June 30, 1941.

Up to March 8, 1941, a total of 684 engineering defense training programs had been approved to be administered by 128 engineering colleges in most of the United States, the District of Columbia, and Puerto Rico.

The engineering defense training program is administered under the chief of the division of higher education of the United States Office of Education, Doctor Fred J. Kelly, with Dean R. A. Seaton on leave from Kansas State College as director of the program. An advisory committee on engineering defense training, which is representative of the engineering and engineering teaching professions, has been set up by the United States Office of Education to aid in formulating policies for the in-service and intensive training programs on the engineering-school level. Contacts between Washington and the engineering colleges and the defense industries are maintained by 22 regional advisers appointed by the United States Office of Education.

Present world conditions demand that technology operates at full speed. The engineer's initiative as well as his creative and managerial talents must be used most extensively in the gigantic armament program of the United States of America. It is hoped that the in-service and preservice intensive programs on the engineering-school level described will prove helpful in meeting the present acute shortage of engineering specialists and will also improve the competence of employed engineers and engineering supervisors so that they may be in a position to design and build better armaments in the shortest possible time.

More Baseball Fields Lighted

GRIFFITH STADIUM in Washington, D. C., will be the ninth major league baseball park to be floodlighted, when the installation now ordered is completed. Eight towers, 150 feet high, will carry a total of 740 floodlights of 1,500 watts rating but operating at 10 volts overvoltage so as to give a light output about 35 per cent above normal rating, with only 16 per cent increase of wattage.

St. Louis, Mo., and Pittsburgh, Pa., joined the night baseball parade during 1940. Sportsman's Field, the home of the St. Louis Cardinals and Browns, is now illuminated with 754 floodlights of 1,500 watts each, mounted on eight steel towers, in banks more than 100 feet above the ground. Forbes Field in Pittsburgh became the brightest lighted park in the United States when its 864 floodlights supplying 210,000,000 candlepower were installed.

The accompanying illustration shows one of the floodlight towers at the Polo Grounds, home field of the New York Giants, also floodlighted during 1940. This tower also is typical of those installed at other fields. A total of 836 floodlights on eight towers 150 feet above the ground supply 200,000,000 candlepower for the Polo Grounds. The illumination level is greatest at the infield, because of the concentration of play.

Institute Activities

Defense Insurance vs. Hysteria

Some Suggestions as to Ways for Engineers to Aid the Defense Program—A Message From President Sorensen

WHEN the second 1940–41 AIEE presidential tour ended February 17th, its president in fulfillment of the business of his office had travelled 27,600 miles, visited 24 Sections and 16 Branches, attended 4 conventions, and addressed more than 50 gatherings; whereupon he said to himself: "I shall spend the next four weeks at my beloved and somewhat neglected California Institute of Technology teaching classes and contributing my bit to the research problems in which I have an interest."

In these days man proposes but Defense disposes. Only ten short days, used in "catching up" the things to be done that had accumulated while attending the highly successful winter convention and making the second tour of Section visits, have elapsed and as we begin this message, we are reluctantly speeding eastward across the continent (a round trip of 5,380 miles) for the purpose of spending two days working as a member of the Society for the Promotion of Engineering Education committee on acceleration of regular undergraduate engineering programs. That committee was appointed to study data submitted by the engineering colleges of the United States and prepare a report which SPEE may use to inform the advisory committee on engineering defense training of the United States Office of Education regarding "the feasibility and advisability of accelerating the regular undergraduate programs of the engineering colleges of the country."

The members of the special committee are:

Dean I. C. Crawford, University of Michigan
President H. T. Heald, Illinois Institute af Technology
Dean C. E. MacQuigg, Ohio State University
Dean E. L. Moreland, Massachusetts Institute of Technology
Dr. R. W. Sorensen, California Institute of Technology
Dean F. L. Wilkinson, University of Louisville
President D. B. Prentice, Rose Polytechnic Institute, *exofficio*
Secretary F. L. Bishop, University of Pittsburgh, *exofficio*

The task responsible for this journey and the labor that must be done free of charge by the eight busy members of the committee impel us to ask some questions: "Is all this commotion in our homeland a hysteria produced by echos from the battlefields of Europe, Africa, and Asia, or is it a sane measure of insurance against sparks flying from that dastardly man-made hell that are falling hot and thick all over the world? Are we so vulnerable that some of those sparks falling in America may grow into damaging conflagrations spreading from within to cause destruction? Are we sufficiently safeguarded by our Defense preparations to repel the fiery blasts back of the sparks that may sweep across land and sea or sail en masse through the heavens to engulf us from without?"

For our part, we are of the opinion that the time has arrived when actions of Defense or protection against slavery by dictatorship are not a sign of hysteria, but rather a new form of insurance as logical and essential for our protection as are the less expensive common forms of insurance which we all use as a matter of course. If we, the citizens of the United States, wish to maintain the right to determine when we will or will not go to war, it is obvious that until such time as nations will respect agreements we must have the power to make those who would destroy the rights of individual freedom respect our ability to defend those rights.

WE MUST NOT FORGET that the liberty we hold so dear can be continued only if we are willing to pay as much in time, energy, and the measure of the sweat of our labors that we call money, as those who are trying to destroy the freedom of the individual are willing to pay for its destruction.

At a price, our fathers bought the liberty for which democracy stands and have maintained it in America for more than one and one-half centuries.

As these lines are written, I glance from time to time through the windows of a speeding train at fertile fields that within my own memory were buffalo grazing grounds covered with sod so tough that every foot of furrow turned was a tussle with nature. Indeed, with my own eyes I saw my father, an immigrant from Norway, patiently turn over that sod with a plow drawn by oxen. (Horses could not do the job, and tractors were unknown as substitutes for draft animals.) He, and the thousands of others who thus labored to advance the land of America from the Atlantic to the Pacific, did not seek a life of ease, but rather sought a life of freedom for us, their children.

How well they builded! We their children enjoy a freedom and standard of living unequalled by the citizens of any other nation recorded in the pages of history. We can look all the world in the face and say "We are freeborn"; and may God grant that our children and children's children may have the right to make the same declaration for a thousand years to come.

Engineers have had a large part in making possible those very high standards of living, because they have created the machines that

Station 5 of the Rochester Gas and Electric Corporation, on the Lower Falls of the Genesee River at Rochester, N. Y. Details and tentative program of the North Eastern District meeting to be held at Rochester April 30–May 2, 1941, appear on pages 177–8 have released men from living by strength of muscle alone.

We must not forget that in so doing they have annihilated many of the influences that time and space had upon man's activities. Engineers made it possible for us to leave our office in Pasadena, California; travel 5,380 miles enjoying a good sleep every night; spend two nights in the luxury of a fine University Club and do two long days' work, in Pittsburgh; and return to the Pasadena office in less than a week of elapsed time—all without at any time experiencing the inconvenience of so much as a delayed meal, an uncomfortable chair or bed, or even an undesirable room temperature in which to rest or work. Indeed, men can now travel comfortably around the world in much less time than men could, at the time the United States was formed, cross the area comprising the original thirteen colonies in a manner that we now would consider a great hardship even though it was the finest type of transportation available at the time. Engineers have made it possible for us to have instant communication with those we love and with our business associates throughout the length and breadth of the United States, or even beyond those limits, if those we would like to reach are not in countries at war or dominated by dictators.

Yes, engineers did all this by "breaking sod" in the realms of time, space, invention, and science—even as our fathers, the so-called pioneers of America, tamed the wilderness of land and sea. Engineers are not knowingly going to stand by and see the machines they have made prostituted by dictators who conquer countries by force and lash the citizens of their own and the captured countries into slavery. This present slavery is ruled by dictators who, for appeasement of the public, are surrounded by puppet executives that, like Charley McCarthy, may be merely $500,000 chunks of wood so long as they can be clad in fine raiment and are admired by the masses that watch them perform. When the dictators can find no further use for them these puppets become just sticks in a woodpile ready to be burned to ashes by the first hobo who may find need for a bit of wood for a little fire to make a cup of coffee.

In 1936, when engineers from 58 countries made a 9,000-mile World Power Conference tour around the United States, the German engineers on that tour said to us one night in a quiet conversation: "You are a prosperous people because you have such a large area under one government. We Europeans must organize our many little countries into a large country under one government and that government must be Germany!" Did these German engineers know that their Germany was rapidly becoming a slave nation in the hands of a dictator and his puppets? Have the ideals of the German engineers become so distorted that they now willingly use their high mentality and almost unsurpassed ability as engineers to provide by the thousands the devilish weapons of destruction now being used so ruthlessly against their fellowmen—noncombatant citizens, women and children as well as men—or are they in the hands of Hitler and his Nazis as helpless as Charley McCarthy sitting on Edgar Bergen's knee? Indeed, perhaps we well may ask: Is Hitler just a Charley McCarthy clowning for his fine clothes and 75 cents a week for the amusement of the citizens of Germany, while the real group responsible for all Europe's troubles manipulates the dummy?

On that World Power Conference tour, during a discussion relating to the war then raging in Spain, some Greek and Spanish members of the party said the only way to stop the spread of that war was for England to step in and call a halt. Did the English engineer, who answered that comment by saying "England is tired of policing Europe" foresee at all what has since come to pass? Is it probable that he now would make such a comment? Or is he, like every other Englishman, at the present time busily engaged in saving by every means within his power what England stands for—liberty and freedom for the individual? Would that English engineer now say "England is tired of policing Europe" and stop there? Or would he add to that statement: " . . . but it must be done, and if England cannot do it alone, or even if she can, would it not be much better to have a democratic United Nations of the World, since there already exists a dictator United Nations of the World?" Yes, let us have a democratic Nations of the World, growing rapidly as nation after nation is added, not because forced by conquest of arms to do so, but because to balance the dictator group the democracies also must organize into a group, rather than try to act singly as individual nations. What would Poland, Holland, Denmark, and Norway do if, knowing what the citizens of those countries now know, they could return to conditions extant in 1936? What would England and the United States do, if knowing what is known today, their citizens could reconsider the problems which faced them in 1936?

When the United States was formed, the problems faced by the original 13 colonies must have appeared as complicated to the citizens of those colonies as do the problems facing the nations of today. Yet at a time when it took much longer to assemble and communicate than it does at present, those 13 colonies formed the United States of America and developed together a security and prosperity for their citizens that never could have been attained by the colonies as 13 separate nations. Yes, the world is now small, as is known to everyone who can read and write or listen to a radio.

Every engineer in the United States should heed well the signs of the times as he plans to serve his country.

Shall that service be rendered blindly or under compulsion, as our European brother engineers serve (for I cannot think their scientific minds believe in dictatorship and slavery though its reward may be a mess of pottage); or are engineers ready to have a voice in determining how the machines they have created shall be used? The question today is not whether there is going to be a United Nations of Europe or perhaps of the World; the question of today is whether there is going to be a democratic United States of the World to balance the dictator United States of the World?

We are helping England, the other great English-speaking unit of government, to stave off destruction in order that America may not be left the sole policing force available for its self protection. Americans who have lived in China for a generation say that if England falls, China will fall. If England and China fall, what would happen to the many countries now unprepared to resist an onslaught by the dictator United States of the World, already tremendously large and daily growing larger? Would America be left to try to police alone the world for a time? Would her citizens become tired of the job in numbers large enough to have us sooner or later fight the same kind of a battle England now is fighting?

But this story grows long because the mission which called us to make this trip has given us opportunity to formulate some of the ideas the present world crises—our present American crisis, if you please—have brought about.

The committee to consider the acceleration of undergraduate engineering courses, mentioned earlier in this message, has met and analyzed data submitted by almost every engineering college in the United States. From these data it is obvious that every one of these colleges and all their faculties favor the greatest haste possible in carrying out the Defense measures now under way. To aid in those measures, the engineering colleges are willing to accelerate the regular engineering courses, even though any such acceleration means a sacrifice of standards of engineering education.

The immediate logical move toward such acceleration is that of moving forward the time of graduation for the engineers of the class of 1942 (the present junior class) by having them continue through the coming summer.

Any accelerated program of engineering education, to be effective, should be an integral part of a completely co-ordinated program of placement for engineers on the part of the Army, the Navy, industry, local draft boards, the public, and all engineers. Such a co-ordinated program should provide for:

1. The deferment of induction of engineering students (those carrying full-course programs) into military service until after the completion of their college courses;
2. The use of engineers only for work where engineering training is required. This feature may call for the transfer to engineering work of engineers now engaged in work that requires very little engineering, and the filling of the positions now held by such engineers with men having less technical training;
3. The release from Army and Navy service of all engineers not engaged in engineering work, and their placement where engineers are needed in essential industries;
4. A very careful consideration by all draft boards of the qualifications of engineers, together with the needs of Army, Navy, industry, and engineering schools for engineers with special training, in order that draft classifications may be so made as to promote maximum efficiency in the Defense Program.

The Sections, Branches, and members of AIEE can help in this great program of trying to have the 12,000 to 14,000 engineers graduating in 1941 satisfy a demand for at least four times that number of young engineers, by becoming acquainted with the work being done by the engineers of their locality and helping to correlate the Defense Program's demand for engineers with the available supply of men qualified to do the work. This may mean arranging a plan of co-operation with employment agencies, placement offices of colleges, and industries, or even of establishing in connection with present Section activities a clearing house for registration of engineers and of the positions requiring engineers. Another service that may be rendered by AIEE members is that of assisting the local draft boards whenever possible by providing them with factual information regarding the places where engineers are needed in numbers greater than the available supply.

North Eastern District Meeting to Be Held in Rochester, April 30-May 2

THE North Eastern District meeting will be held in Rochester, N. Y., April 30 to May 2, 1941, with headquarters at the Sagamore Hotel. An interesting and varied program of technical sessions, inspection trips, entertainment, and special features has been arranged.

TECHNICAL SESSIONS

The program includes seven sessions to be held during the mornings and afternoons. Four of these will be devoted to the presentation of technical papers, while a fifth will include addresses by well-known speakers designed to interest many members. In two others papers will be presented by students.

STUDENT BRANCH CONVENTION

Enrolled students are invited to attend the Student Branch convention. Two parallel sessions devoted to technical papers will take place on Friday morning, with the usual counselors' luncheon at noon. The executive committee of the North Eastern District has made the usual grant for prizes and travel allowance. The final list of paper titles and names of authors is scheduled to reach all Branches in the District about two weeks prior to the meeting.

ENTERTAINMENT

A stag smoker will be held on Wednesday evening, April 30, which will include a varied program of entertainment and a buffet supper. Tickets for the event may be secured at the registration desk.

An informal banquet will be held on Thursday, May 1, at the Rochester Club, located directly opposite headquarters. Doctor R. W. Sorensen, president, AIEE, will address the members and guests, and Doctor Alan Valentine, president of the University of Rochester, will be the principal speaker. Everett S. Lee, vice-president, North Eastern District, will act as toastmaster. Tickets may be reserved in advance and will be available at the registration desk.

Entertainment for women guests will be provided in the form of visits to interesting

---

Tentative Rochester Program

- **PAMPHLET** reproductions of authors' manuscripts of the numbered papers listed in this program may be obtained as noted in the following paragraphs.
- **ABSTRACTS** of papers appear on pages 179–80 of this issue of Electrical Engineering.
- **PRICES** and instructions for securing advance copies of these papers accompany the abstracts. Mail orders are advisable, particularly from out-of-town members, as an adequate supply of each paper at the meeting cannot be assured. Only numbered papers are available in pamphlet form.
- **COUPON** books in $5.00 denominations are available for those who may wish this convenient form of remittance.
- **ALL PAPERS** regularly approved by the technical program committee ultimately will be published in Transactions; many will appear also in Electrical Engineering.

Wednesday, April 30

9:00 a.m. Registration

10:00 a.m. Communication

H. E. Gordon presiding

Address of welcome. Everett S. Lee, vice-president, North Eastern District

Address, "Communications in National Defense." Doctor R. H. Manson, vice-president, Stromberg-Carlson Telephone Manufacturing Company

Address, "Unusual Applications of Electrical-Engineering Principles in Television." Doctor George R. Town, engineer, Stromberg-Carlson Telephone Manufacturing Company

Address, "High-Speed Photography with the Edgerton Lamp." Ford M. Brown, research laboratories, Eastman Kodak Company

Address, "Some Considerations in the Design of Electromagnetic Relays for Use in Telephone Systems." Oliver L. Angevine, Jr., engineer, Stromberg-Carlson Telephone Manufacturing Company

2:00 p.m. Central Stations

E. K. Huntington presiding

Address. Herman Russell, president, Rochester Gas and Electric Corporation

41-84. Methods of Determining Natural Frequencies in Coils and Windings. L. V. Bewley, J. H. Hagenguth, and F. R. Jackson, Jr., General Electric Company

41-90–ACO.* Simplified Methods of Calculation for Long Transmission Lines. E. E. George, Ebasco Services, Inc.

41-85. Surge Characteristics of Two-Winding Transformers. Reinhold Rüdenberg, Harvard University

8:00 p.m. Stag Smoker

Thursday, May 1

10:00 a.m. General Session

Colonel Carey H. Brown presiding

Address, "Priorities in Men." Doctor Harvey N. Davis, president, Stevens Institute of Technology

41-93-ACO.* Radio Navigation and an Omnidirectional Radio Range. David G. C. Luck, RCA Manufacturing Company, Inc.

Presentation of awards

2:00 p.m. Selected Subjects

H. H. Race presiding

Address, "The Engineering Societies and National Defense." H. H. Henline, national secretary, AIEE

41-92. Photographic Study of A-C Arcs in Flowing Liquids. J. Slepian and T. E. Browne, Jr., Westinghouse Electric and Manufacturing Company

41-89. The Determination of Magnitude and Phase Angle of Electrical Quantities. Eric A. Walker, University of Connecticut

41-91. The Dielectric Strength of Glass—An Engineering Viewpoint. E. B. Shand, Corning Glass Works

7:00 p.m. Banquet

Everett S. Lee, vice-president North Eastern District, presiding

Welcome to members, Doctor R. W. Sorensen, president, AIEE

Address, Doctor Alan Valentine, president, University of Rochester

Friday, May 2

8:00 a.m. Student Sessions

E. A. Walker presiding

Selected subjects

12:00 noon Branch Counselors' Luncheon

2:00 p.m. Industrial Applications

J. Leo Scanlon presiding

41-86. Theory of the Brush-Shifting A-C Motor—Part I. A. G. Conrad, F. Zweig, and J. G. Clarke, Yale University

41-87. Theory of the Brush-Shifting A-C Motor—Part II, Characteristics. A. G. Conrad, F. Zweig, and J. G. Clarke, Yale University

41-83. Overvoltages in Polyphase Induction Motors During Single-Phase Operation. C. Macmillan and G. K. Carter, General Electric Company

41-82. Power Supply for Resistance-Welding Machines—III, Factory Wiring for Resistance Welders. Subcommittee on Power Supply for Welding Operations, L. W. Clark, chairman. Presentation by J. D. Wright, chairman, committee on electric welding

41-88. Ampere-Squared-Second Recorder. T. A. Rich, General Electric Company

---

*ACO: Advance Copies Only available; not intended for publication in TRANSACTIONS.

Part of Rochester's industrial section, seen from the air

points in the city as well as a schedule of luncheons and dinners.

INSPECTION TRIPS

The requirements of national defense make it impracticable at this time to present a regular schedule of inspection trips. However, arrangements will be made by the committee to provide for visits to industrial plants and utility stations wherever feasible. A program will be available at the registration desk.

COMMITTEES

District meeting: Everett S. Lee, vice-president, North Eastern District; R. D. Lorraine, secretary-treasurer, North Eastern District; A. G. Conrad, H. D. Griffith, O. E. Sawyer, M. G. Northrup, E. A. Gruppe, C. E. Tuites, W. F. Cotter.

Technical program: J. H. Rogers, *chairman;* A. G. Schifino, G. R. Town, C. L. Smith, R. C. Keberle, E. M. Morecock, F. C. Starr, W. C. Winterroth, A. V. Dasburg, Oliver L. Angevine, Jr.

Transportation and trips: W. Criley, *chairman;* Oliver L. Angevine, Jr., C. S. Chase, W. D. Hailes, E. K. Huntington, Lee McCanne, F. McVittie, Brian O'Brien.

Hotels and registration: O. Laurence Angevine, *chairman;* A. F. Luckett, R. G. Burns, A. F. Martin, R. A. Whitford, A. E. Schell, R. H. Rankin.

Entertainment and banquet: R. A. Whitford, *chairman;* C. G. Plomasen, W. J. Scanlan, C. A. James, J. H. Taber, G. H. Haupt.

Finance: H. J. Klumb, *chairman;* C. F. Harris, *treasurer;* O. Laurence Angevine.

Publicity: E. B. Kempster, *chairman;* O. Laurence Angevine, J. A. Gienger, G. E. Baker, H. J. Genthner, J. H. Levis, Jr.

Reception: C. E. Tuites, *chairman;* L. A. Waasdorp, C. S. Barrow, E. R. Crofts, W. K. Howe, Colonel C. H. Brown, L. B. Swift, J. W. Morrison, H. H. Sullivan, T. L. Lee, Mark Ellingson, J. H. Snyder.

Women's entertainment: Mrs. C. L. Smith, *chairman;* Mrs. O. Laurence Angevine, Mrs. J. H. Rogers, Mrs. C. F. Harris, Mrs. C. E. Tuites, Mrs. B. M. Werly, Mrs. R. A. Whitford, Mrs. W. F. Cotter.

Student sessions: E. A. Walker, District Branch counselor.

Future AIEE Meetings

North Eastern District Meeting
Rochester, N. Y., April 30–May 2, 1941

Summer Convention
Toronto, Canada, June 16–20, 1941

Pacific Coast Convention
Yellowstone National Park, August 27–29, 1941

South West District Meeting
St. Louis, Mo., October 8–10, 1941

Southern District Meeting
New Orleans, La., December 3–5, 1941

Winter Convention
New York, N. Y., January 26–30, 1942

National • • • •

Summer Convention Committee Plans Unusual Program

Plans for the 1941 AIEE summer convention, to be held at the Royal York Hotel, Toronto, Canada, June 16–20, are already taking definite shape. The summer convention committee, which has been meeting regularly for several months now, is working on the assumption that this year's gathering will set a new record for attendance.

The committee points to many factors that make Toronto a unique convention city of special interest to American visitors in this particular year. Not the least of these factors is the location of the city in the heart of Canada's industrial region. Canada is a nation at war, and convention-attenders will see signs of war activity everywhere—industries working long hours; airmen, soldiers, and sailors on the streets. Members and guests will visit plants in which production has been rising steeply since September 1939.

Despite the fact that Canada is at war, United States citizens may enter the country as easily and move about as freely as ever (*EE, March '41, p. 134*).

Among the factors expected to increase attendance is the newly completed Queen Elizabeth Way—the superhighway from Niagara Falls to Toronto. Many probably will travel this highway if only to see the longest stretch of highway lighting in the world. By June the lighting will be completed from one end to the other.

The Royal York Hotel, Toronto, summer convention headquarters, is said to be the largest hotel in the British empire

Membership—

Mr. Institute Member:

What the future holds in store for us may be in doubt, but one thing is certain, the electrical engineer needs the Institute today more than ever before, as it is the national organization of his profession. It follows that the Institute needs the membership of all engineers qualified for membership and it is our duty to bring the advantages of membership to their attention.

About 800 of your fellow members have volunteered and are devoting their time and energy to the membership work of the Institute. But if they are to succeed in a big way you must help them to locate eligible prospects. That is why we ask you to send in their names to your Section membership committee.

O.C.Brill

Chairman, National Membership Committee

When Canada's natural scenic beauty and facilities for sport are also considered, the convention committee's prophecy of a record attendance seems only reasonable. With such an attendance in mind, the committee is gathering outstanding technical papers and laying plans for several novel entertainment and sports features.

Officials of the Lynn Gas and Electric Company sponsoring the pageant "The Torch of Civilization" included (top row, left to right) A. B. Whitehouse (A'39) superintendent, electric distribution; E. W. Allen, merchandise manager; J. W. Lingary (M'32) superintendent, electric plant; I. A. Patten (A'28) general superintendent, electric department; (second row, left to right) F. M. Kelley, president; J. A. Cook (A'15, F'30) general manager; E. H. Fraser, treasurer

Branch

University of Connecticut Branch Holds Installation Meeting

Authorized by the AIEE board of directors at its meeting January 30, 1941 during the winter convention, the University of Connecticut Branch held its first meeting at Storrs, Conn., February 20, 1941. Doctor E. A. Walker, associate professor of electrical engineering, University of Connecticut, and chairman of the District 1 committee on student activities, was named counselor of the new Branch. The officers are Arthur Eckels, chairman; John Cooledge, vice-chairman; Anthony Tiezzi, secretary-treasurer.

Principal speaker was E. S. Lee, General Electric Company, vice-president of the North Eastern District, who talked on "The Contributions of the Electrical Engineer". Doctor Charles F. Scott, founder of Student Branches, sent best wishes for the success of the Branch. Guests present included:

R. G. Warner, New Haven, AIEE director; W. B Hall, counselor, and James Hasney, chairman, Rhode Island State College Branch; Victor Siegfried, counselor, and Peter Jaremko, chairman, Worcester Polytechnic Institute Branch; A. G. Conrad, counselor, Yale University Branch

Section

Pittsburgh Section Hears Talk on Submarines

At a joint technical meeting of the AIEE Pittsburgh Section and the electrical section of the Engineers' Society of Western Pennsylvania, February 25, 1941, Lieutenant Commander J. P. Thew, in command of inspection at Cleveland Diesel-engine division, General Motors Corporation, spoke on "The Submarine, Its Powering, Maneuvering, and Control". Motion pictures illustrated the address, at which about 460 were present.

Pageant on Light and Civilization Presented at Lynn

Sponsored by the public utilities committee of the AIEE Lynn Section and officials of the Lynn Gas and Electric Company, a pageant, "The Torch of Civilization," was presented at Lynn, Mass., February 11, 1941, to an audience of about 1,200, including members of the Lynn Section, the New England section of the Illuminating Engineering Society, special guests, and others. The pageant, presented on the 94th anniversary of Edison's birth, depicted the development of light from the pre-Christian era to the present, with one scene showing Edison's discovery of the incandescent lamp. Except for the title, which was used by permission of Doctor Matthew Luckeish (A'11, M'15) General Electric Company, author of the recent book of that name, the production was an original rendering of a technical message in dramatic form. Members of the Lynn Gas and Electric Company Players constituted the cast; A. B. Whitehouse (A'39) Lynn Gas and Electric Company, was in charge of production, assisted by Moorhead Wright, Jr., General Electric Company, and J. A. Melanson, Lynn Gas and Electric Company.

New York Section and IES Hold Joint Meeting on Protective Lighting

Meeting jointly on February 25, 1941, the New York Sections of the AIEE and the Illuminating Engineering Society heard A. H. Crowl, special agent, Federal Bureau of Investigation, and D. H. Tuck, electrical engineer, Hollophane Company, discuss the protection of American industry. Declaring that there are no organized groups of saboteurs operating in the United States, Mr. Crowl blamed disregard of safety rules for many of the accidents attributed to sabotage, and emphasized illumination, along with proper fencing and screening, as most important in preventing spies from entering industrial plants. Mr. Tuck discussed various aspects of protective lighting in detail.

Abstracts

TECHNICAL PAPERS are previewed in this section as they become available in advance pamphlet form. Copies may be obtained by mail by remitting price indicated to the AIEE order department, 33 West 39th Street, New York, N. Y.; or at five cents less per copy if purchased at AIEE headquarters or at AIEE convention or District-meeting registration desks.

The papers previewed in this issue will be presented at the North Eastern District meeting, Rochester, N. Y., April 30–May 2, 1941

Air Transportation

41-93—ACO—New Method for Radio Guidance of Aircraft; *D. G. C. Luck. 25 cents by mail.* The problem of navigation and the means at hand for its solution are described. Some principles of radio direction finding are set forth and shown to lead to three main systems of use which are compared as to operating properties. The operation of a development of one system, giving direct omnidirectional bearing indications, is explained. Experimental omnidirectional range equipment is described. Finally, the actual use of the range in flight is explained and some results of flight tests of experimental omnidirectional ranges are presented as indicative of their present performance.

Basic Sciences

41-91—The Dielectric Strength of Glass—An Engineering Viewpoint; *E. B. Shand (M'29). 15 cents by mail.* Available data on the dielectric strength of glass show such wide variations that the insulation engineer is faced with a difficult problem in making applications of this material. A study has been made to correlate such data, both from the literature and from original sources, with the result that characteristic curves have been worked out for certain boundary conditions. There are a number of factors which influence the breakdown strength of insulation, one of the most important being the "edge effect", which may result from several specific causes. The use of oil as an ambient medium in making dielectric tests on a material such as glass produces a severe type of edge effect which may vitiate seriously the results obtained, so that adequate consideration must be given this matter. With the use of the characteristic breakdown curves and other information, the insulation engineer can make an intelligent approximation of the breakdown strength of glass under certain conditions which, if not of a high degree of accuracy, will give him a better perspective of the possibilities of this application of glass. Corresponding characteristic curves for porcelain of the same general form show several interesting comparisons.

Electric Welding

41-82—Power Supply for Resistance-Welding Machines—III. Factory Wiring for Resistance Welders; *Subcommittee on Power Supply for Welding Operations, Committee on Electric Welding, L. W. Clark (A'25), chairman. 15 cents by mail.* With more and more resistance welders being installed, particularly in conjunction with the new defense plants being built throughout the country, it is essential that an adequate power supply and proper factory wiring be provided in each case. Adequate electric service for large resistance welders is of greater moment and involves considerably more expense than the corresponding service for ordinary machine-tool installations, because of the low power factor and high single-phase kilovolt-ampere demand usually inherent with this type of equipment. The report shows how to lay out properly a plant distribution system for serving welders. It includes the necessary tables, charts, and illustrative examples of successfully operating installations, ranging in size from a small welding shop to a large manufacturing plant.

Electrical Machinery

41-84—Methods of Determining Natural Frequencies in Coils and Windings; *L. V. Bewley (M'37), J. H. Hagenguth (A'28), and F. R. Jackson, Jr. (A'40). 20 cents by mail.* A knowledge of the natural frequencies of transformer, reactor, and generator windings is essential for the determination of the transient response of such coils to lightning waves and switching surges, as well as for the calculation of the recovery characteristics of circuit breakers and expulsion gaps. Different testing methods have been employed to determine these natural frequencies, and usually it has been taken for granted that all these different testing procedures give results in substantial agreement. Recently, however, in a study of transformer transients it was found that several different methods of test failed to agree, and an investigation as to the cause of the discrepancies disclosed that all of these usual methods are not equally valid or reliable. It is the object of this paper to discuss various testing procedures, and to point out their theoretical limitations toward yielding the supposed information. The voltage distribution along the winding of a grounded-neutral transformer is discussed analytically and the basic equations developed. Results of voltage-distribution tests made by several methods are reported and compared.

41-86—Theory of the Brush-Shifting A-C Motor—I; *A. G. Conrad (M'40), F. Zweig, and J. G. Clarke (appl. pending). 20 cents by mail.* This is the first of a series of papers explaining the theory and the principles of operation of the brush-shifting a-c motor. Operation of the machine, either as a motor or a generator, is explained on the basis of the superposition of currents. The theory of the primary current loci is developed for both high-speed and low-speed adjustments. A method of determining the primary current loci from no-load measurements is presented. Experimental data have shown the theory to be valid.

41-87—Theory of the Brush-Shifting A-C Motor—II; *A. G. Conrad (M'40), F. Zweig, and J. G. Clarke (appl. pending). 15 cents by mail.* In the preceding paper (part I) of this series, a simple theory underlying the circle diagram of the brush-shifting a-c motor was presented. It is the purpose of this paper to advance this theory, and to show how it can be used to determine such quantities as efficiency, current, torque, and speed for different conditions of operation. The procedures outlined and explained have been checked experimentally, and found to be accurate for both high-speed and low-speed adjustments.

41-85—Surge Characteristics of Two-Winding Transformers; *Reinhold Rüdenberg (M'38). 25 cents by mail.* The paper shows the performance of transformers with two windings in rapid-transient state when surges develop in their conductors. The velocity of traveling waves along the wires of each of the windings is equal to the velocity of light in the dielectric space. The surge impedance of a winding is determined by the turn-density of the coils and the insulating distances and is in the range of 100 up to 20,000 ohms for power transformers of low voltage and high power up to high voltage and low power. On the arrival of a surge at the terminals, two different wave fields travel axially through the windings, a slow one coupled with the high-voltage coils and a fast one coupled with the low-voltage coils, both propagating with light-velocity helically in their respective windings. This mechanism effects a transmission of surge voltages between the two windings, entirely different from any steady-state transformation. The surge-coupling factors of the two windings are determined by the ratio of the insulating distances and by the square-root of the turn ratio.

Industrial Power Applications

41-83—Overvoltages in Polyphase Induction Motors During Single-Phase Operation; *C. Macmillan (M'35) and G. K. Carter (A'36). 20 cents by mail.* The object of the present paper is to record some of the results of tests and calculations undertaken to obtain more definite data on the factors which limit the safe and appropriate use of polyphase induction motors subject to temporary single-phase conditions. Calculations have been made, by several analytical methods, and some results plotted as graphs, which serve to explain the causes of the wave forms obtained in test and to illustrate the extent to which they can be duplicated by calculated results. From the comparison of calculated and test results, qualitative conclusions are drawn as to probable modifications introduced by factors which it is impossible to include in the theoretical analysis. Attention is called to the possibilities of dangerous excessive voltages in motor windings due to imperfections, defects, or inadequate maintenance of control equipment.

Instruments and Measurements

41-89—The Determination of Magnitude and Phase Angle of Electrical Quantities; *Eric A. Walker (A'34). 15 cents by mail.* Although the three-voltmeter method for measuring the relative magnitude and phase angle of two voltages or currents is well known, the use of vacuum-tube voltmeters, which draw negligible amounts of energy from the circuit, permits the use of the method for purposes that previously have not been considered. A further improvement of the scheme by balancing out one component of either voltage or current adds to the accuracy of the results. No attempt is made to extend the method to extremely small angles because the primary object is to produce a rugged, portable instrument for use in field tests. A further advantage is that because the method has one balancing element and an indicating instrument it is possible to follow rapid changes in power factor. The method is considered for two purposes; namely, the measurement of the capacitance and power factor of imperfect capacitors, and the measurement of the ratio and phase angle of current transformers.

41-88—Ampere-Squared-Second Recorder; *T. A. Rich. 15 cents by mail.* An instrument is described which records the ampere-squared-seconds in an electrical impulse of less than 0.5-second duration. A number of these have been used in resistance-welding applications to monitor the electrical variables and have contributed greatly to the uniformity of welds. The problem of indicating $^1/_{60}$-second impulses at the rate of 100 a minute with the same device that will integrate correctly a half-second impulse has been solved by the use of a moving element with an infinitely long natural period, combined with a supplementary circuit which returns the element to the starting position in a fraction of a second.

Protective Devices

41-92—Photographic Study of A-C Arcs in Flowing Liquids; *J. Slepian (F'27) and T. E. Browne (A'36). 15 cents by mail.* An apparatus has been constructed for so drawing an arc under oil or water that it can be subjected to a wide range of independently varied fluid velocities and pressures, and in which the arc and its associated gas bubble can be photographed at any point in the current cycle, more particularly at current zero. A large number of single and high-speed sequence photographs have been obtained of arc bubbles in various flow-directing structures. These have revealed, in general, that:

1. Displacement of the arc bubble by liquid dielectric follows arc extinction by an appreciable time lag;
2. Arc extinction is favored by the occurrence of a small bubble section at current zero;
3. The arc bubble undergoes an oscillatory variation in size and shape. This oscillation is at a considerably higher frequency than that of the current variation and is not synchronized with it;
4. For arcs in small bubbles near their critical conditions for extinction, there is no observable correlation at current zero between bubble appearance and tendency to re-ignite.

These observations are sharply at variance with a displacement or liquid-barrier theory of arc extinction, but suggest that the initial recovery of dielectric strength is by the arc bubble itself.

Transmission and Distribution

41-90—Simplified Methods of Calculation for Long Transmission Lines; *E. E. George (F'36). 25 cents by mail.* For lines around 300 miles in length, ordinary engineering accuracy in determining performance requires the use of the so-called "long-line" or "rigorous" methods of calculation. No matter whether graphic or analytic procedure is used, any "long-line" method requires the determination of certain supplementary factors prior to further calculation or graphic construction. It is essential to evaluate these factors with the greatest possible ease and accuracy. Conventional methods of determining θ, Z_0, A, B, C, and D (or their components) involve complex quantities and vector algebra. It is the purpose of this paper to describe a new and relatively simple method of calculating the above factors. A new and more useful line loss formula is also derived. In the method presented, complex or vector algebra is discarded and plain arithmetical formulas are used. There are no vector quantities or operations in these new formulas, since the scalar or absolute value of each quantity is used. Tables of plain circular and of plain hyperbolic functions are the only tables required.

Personal • • •

R. A. McCarty (A'16, M'32) manager of the steam division, Westinghouse Electric and Manufacturing Company, Philadelphia, Pa.; **F. D. Newbury** (A'07, F'21), manager of the emergency products division, Pittsburgh, Pa.; and **A. C. Streamer** (A'10), general manager of the East Pittsburgh division, recently have been elected vice-presidents of the company. Mr. McCarty was born at Mooresburg, Tenn., October 2, 1882, and graduated in electrical engineering at the University of Tennessee in 1903. He entered the student training course of the Westinghouse company the same year. He became successively design and section engineer in 1911, division engineer in 1927, and manager of the power engineering department in 1930. In 1935 he was made manager of the generator operating division, in 1937 manager of the small motor plant at Lima, Ohio, and in 1938 manager of the steam division. Mr. Newbury, who was born at Brooklyn, N. Y., June 9, 1880, received the degree of mechanical engineer from Cornell University in 1901 and also entered the student course at East Pittsburgh the year of his graduation. He became design engineer in 1903, section engineer in 1907, manager of power engineering department in 1911, and general manager of machinery engineering in 1931. He was appointed assistant to vice-president in 1935, dealing with budgets and administrative problems, and in 1937 was made economist of the company. He became manager of the new products division in 1938 and of the newly created emergency products division in 1940. He was a director of the Institute 1918–22. Mr. Streamer was born at Boulder, Colo., November 23, 1885, and received the degree of bachelor of science in electrical engineering from the University of Colorado in 1907. He entered the student course the same year and in 1920 was appointed assistant to the manager of the supply department. He became assistant sales director in 1924, sales manager of the diversified products division in 1931 and of the transportation division in 1933. He was appointed manager of the switchgear division in 1936 and general manager of the East Pittsburgh division in 1939.

A. N. Goldsmith (M'15, F'20) consulting industrial engineer, New York, N. Y., has been awarded the Medal of Honor of the Institute of Radio Engineers for 1941, "for his contributions to radio research, engineering, and commercial development, his leadership in standardization, and his unceasing devotion to the establishment and upbuilding of the Institute and its *Proceedings*." Born September 15, 1887, at New York, N. Y., he received the degrees of bachelor of science, 1907, from the College of the City of New York, doctor of philosophy, 1911, Columbia University, and the honorary degree of doctor of science from Lawrence College, 1935. He was a member of the faculty of the College of the City of New York 1911–26, becoming professor in charge of the electrical engineering department in 1916. He was consulting radio engineer for General Electric Company, 1916–18; director of the research department, Marconi Wireless Telegraph Company of America, 1917–19; director of research, chief broadcasting engineer, and vice-president, Radio Corporation of America, 1919–33. Since 1933 he has practiced as a consulting industrial engineer. He was for many years editor of the *Proceedings* of the IRE, of which he is a past president. He is also a past president of the Society of Motion Picture Engineers, and has been active in the work of the American Standards Association and the International Electrotechnical Commission. In 1940 he was honored as a "modern pioneer" by the National Association of Manufacturers. He is the author of books and articles on radio.

William Spraragen (A'17, M'26) technical secretary and editor, American Welding Society, New York, N. Y., has been awarded the Samuel Wylie Miller Medal of the society for 1940, "for his work on the welding research committee, as editor of the *Welding Journal*, and his part in promoting the ideals and work of the American Welding Society." A native (1895) of Warwick, N. Y., he received the degree of bachelor of engineering from Union College in 1916. He was employed by the General Electric Company, Acorn Insulated Wire Company, and Westinghouse Electric and Manufacturing Company before becoming instructor in electrical engineering, Oklahoma Agricultural and Mechanical College, Stillwater, in 1917. At this time he was assistant chairman of the electric welding research committee of the National Research Council and the Emergency Fleet Corporation. He was instructor in electrical engineering at the University of Washington, Seattle, 1918–19. In 1920 he became secretary of the NRC's division of engineering and industrial research, secretary of the American Bureau of Welding, and editor of the *Journal* of the American Welding Society continuing in the first two positions until 1934. He has been technical secretary of AWS since 1922, and is also secretary of the welding research committee of the Engineering Foundation. He is president of the Spraragen Engineering Corporation, New York.

Augustin Frigon (A'20) assistant general manager, Canadian Broadcasting Corporation, Montreal, has been selected as one of eight initial recipients of the Julian C. Smith Memorial Medal, established in memory of the late Julian C. Smith (A'88, M'99, F'13) and awarded by the Engineering Institute of Canada for outstanding service in the development of Canada. Mr. Frigon, a native (1888) of Montreal, received the degrees of bachelor of science and civil engineer, 1909, and electrical engineer, 1911, from the École Polytechnique, Montreal. From 1911 to 1914 he was electrical engineer for the Quebec Public Utilities Commission, and also carried on consulting practice. From 1910 to 1917 he headed the electrical-engineering laboratory at the École Polytechnique and in 1917 became head of the electrical-engineering department. He was commissariat general of Canada in Paris, France, 1920–22, and on his return to Montreal became director of the École Polytechnique and general director of technical education for the Province of Quebec, later becoming dean of the École Polytechnique. He was one of three engineers appointed to the Quebec Electricity Commission on its formation in 1936, and was made its president. Later in 1936 he was appointed assistant general manager of the newly formed Canadian Broadcasting Corporation.

R. W. Preston (A'23, M'28) appraisal engineer, Pacific Power and Light Company, Portland, Ore., has been elected president of the Professional Engineers of Oregon for 1941. **C. B. Carpenter** (A'23, M'34) engineer, Pacific Telephone and Telegraph Company, Portland, has been elected vice-president; **F. D. Weber** (A'09, M'30) chief electrical engineer, Oregon Insurance Rating Bureau, Portland, has been elected treasurer; and **O. L. LeFever** (A'10, M'21) general superintendent, Northwestern Electric Company, Portland, has been elected a trustee. The following Institute members were elected life members of the Professional Engineers of Oregon: **F. D. Weber** (A'09, M'30); **R. H. Dearborn** (A'07, F'30) dean of engineering, Oregon State College, Corvallis; **Walter Haynes** (A'35) dean of engineering, Oregon Institute of Technology, Portland; **L. T. Merwin** (A'10, F'33) president, Northwestern Electric Company, Portland; **F. H. Murphy** (A'07, F'30) consulting engineer, Portland General Electric Company, Portland; **H. A. Rands** (A'19) associate hydroelectric engineer, Portland District, United States Army Engineer Corps; **J. C. Stevens** (A'20, M'30) consulting engineer, Stevens and Koon, Portland.

Frederick Krug (A'17, F'36) formerly supervisor of southern properties, Montreal Engineering Company, Montreal, Quebec, Canada, has been appointed chief engineer of the company. He was born at New York, N. Y., October 12, 1893, and studied at Cooper Union, New Mexico School of Mines, and Massachusetts Institute of Technology. From 1917 to 1921 he was employed by the New York and Honduras Rosario Mining Company, San Juancito, Honduras, as assistant superintendent and superintendent of the electrical department.

His service with that company was interrupted by eight months as war instructor at Carnegie Institute of Technology, Pittsburgh, Pa., in 1918. In 1922 he became superintendent of hydroelectric plants at Comerio Falls, Puerto Rico, for the Porto Rico Railway, Light and Power Company, becoming superintendent of power production for that company in 1924, assistant to president, 1926, and vice-president and general manager, 1927. He continued in the last position until 1936 when he went to Montreal.

H. W. Clapp (A'08, M'13) general manager, aircraft construction, Department of Supply and Development, Commonwealth of Australia, Melbourne, was included in the Australian list of New Year Honors as Knight of the British Empire. Born in Melbourne, May 7, 1876, he spent five years with the Brisbane (Australia) Tramways Company before coming to the United States in 1902. He was employed by General Electric Company 1902–08, being engaged on several large railway electrifications. He then became assistant chief electrical engineer of the Southern Pacific Company, and later was first general superintendent and then general manager of the Columbus (Ohio) Railway, Power, and Light Company. He returned to Australia in 1920 as chairman of the Victorian Railways Commission, and took his present position in 1939.

W. H. Harrison (A'20, F'31) vice-president and chief engineer, American Telephone and Telegraph Company, has been assigned broader duties under the reorganization of the original national defense commission into the Office of Production Management. He heads one of three branches, that of shipbuilding, construction, and supplies, in the production division of OPM. His former assignment was co-ordinator of construction contracts. Mr. Harrison, who is a past president of the Institute, went to the defense commission in the summer of 1940. **Mark Eldredge** (A'14, F'33) who was director of the electrical division of the City of Memphis, Tenn., Light, Water, and Gas Division 1924–40, is now devoting full time also to the work of the Office of Production Management, Washington, D.C. He is a past vice-president and currently a director of AIEE.

Merrill De Merit (M'40) formerly general engineer, West Penn Power Company, Pittsburgh, Pa., has been appointed chief power engineer, Tennessee Valley Authority, Chattanooga, Tenn. He received the degree of bachelor of science in electrical engineering from the University of Wisconsin in 1914. He was engineer in the distribution engineering department of the Detroit (Mich.) Edison Company for about four years before going with the West Penn Power Company in 1922 as distribution engineer. He spent some time as assistant to the president on economic studies, and from 1929 to 1935 was assistant to the chief engineer of the West Penn Electric Company. He had been general and planning engineer of the former company since 1935.

M. E. Strieby (M'22) formerly high-frequency engineer, transmission development department, Bell Telephone Laboratories, New York, N. Y., has been appointed transmission engineer, long lines department, American Telephone and Telegraph Company, New York. He was transferred to the Laboratories in 1929 from the department of development and research of the American Telephone and Telegraph Company, where he had been employed since 1919. **J. F. Wentz** (A'24) engineer in charge of line engineering and measurements, transmission development department, becomes high-frequency engineer. He has been with Bell Laboratories and Western Electric Company since 1919.

R. E. Doherty (A'16, F'39) has been appointed as one of nine men to constitute a new agency of the Office of Production Management—the Production Planning Board—which is supposed to serve the double-barrel purpose of centralized planning of the current defense program and long-range planning for the inevitable future. Doctor Doherty, president of Carnegie Institute of Technology, and chairman of Engineers' Council of Professional Development, long has been active in AIEE industrial and educational circles. He is a representative of United States education on the new board.

F. L. Snyder (A'34) formerly section engineer, Westinghouse Electric and Manufacturing Company, Sharon, Pa., has been appointed manager of insulator and regulator engineering, transformer division, Sharon. **W. A. Sumner** (A'30) formerly section engineer in charge of small distribution transformer design, has been made manager of distribution transformer engineering in the same division. **C. W. Diehl** (A'34, M'39) formerly general foreman, has been made supervisor of quality control, and **A. D. Forbes** (A'32) has been appointed development section engineer, both in the transformer division.

H. S. Hubbard (A'23, M'35) designing engineer, General Electric Company, Pittsfield, Mass., received a Charles A. Coffin Foundation award for 1940 for the development and design of a 1,400,000-volt d-c generator to provide power for an X-ray tube used by the National Bureau of Standards. The awards are presented annually to General Electric employees for outstanding contributions to the progress of the company and to the electrical arts. Mr. Coffin was graduated from Pratt Institute in 1915 as an industrial electrical engineer. He has been with General Electric since 1920.

E. S. McConnell (A'29, M'36) has been appointed engineer on the staff of the Edison Electric Institute, New York, N. Y. He was electrical engineer with the Anaconda Wire and Cable Company, Hastings-on-Hudson, N. Y., from 1928 to 1937, when he received a leave of absence to serve the Copper Wire Engineering Association, Washington, D. C., in charge of field engineering service on projects sponsored by the Rural Electrification Administration. He returned to the Anaconda company for a time in 1940 and more recently has been in private consulting practice on rural electrification.

W. A. Perry (M'38) superintendent, electrical and power departments, Inland Steel Company, East Chicago, Ind., has been elected president of the Association of Iron and Steel Engineers for the coming year. A native (1894) of New York, he went to the Inland Steel Company as an apprentice in 1910, becoming mill motor foreman in 1919. He became assistant superintendent of the power department in 1925, assistant superintendent of the electrical department in 1927, and has been superintendent of the two departments since 1931.

R. R. Pittman (A'28) formerly electrical engineer, Arkansas Power and Light Company, Pine Bluff, has been appointed chief engineer. Born June 27, 1894, at Ottumwa, Iowa, he received the degree of bachelor of science in electrical engineering from Iowa State College in 1917. During the World War he was an instructor for the United States Army Signal Corps at the University of Oklahoma. Since 1918 he has been with the Arkansas Power and Light Company, first as distribution engineer and since 1925 as electrical engineer.

E. T. B. Gross (A'34, M'40) former head of the engineering division, central-station department, A.E.G.-Union Electric and Manufacturing Company, Vienna, has been appointed Westinghouse research associate at Cornell University, Ithaca, N. Y. He received the degrees of electrical engineer, 1923, and doctor of science, 1932, from the Vienna Institute of Technology. He was associated with A.E.C.-Union from 1924 to 1938. For the past year he has been a visiting doctor at Cornell and engaged in consulting practice at Ithaca.

F. W. Rulison (M'32) has retired as chief engineer of the Iowa area of the Northwestern Bell Telephone Company, Des Moines. He was born March 12, 1884, near Topeka, Kans., and entered the employ of the Iowa Telephone Company, predecessor of Northwestern Bell, in 1902. In 1911 he became plant engineer for the Iowa company and in 1919 plant superintendent. He was made outside plant engineer for Northwestern Bell Telephone Company in 1925 and has been chief engineer of the Iowa area since 1928.

A. R. Rutter (A'35) formerly section engineer, watt-hour meters, meter division, Westinghouse Electric and Manufacturing Company, Newark, N. J., has been appointed assistant manager of the engineering department of the meter division. He entered the employ of the company at East Pittsburgh in 1918, and has been section engineer since the transfer of the meter division to Newark in 1928.

C. C. MacAllister (A'37) formerly in charge of traffic control and signal equipment sales, General Electric Company, Schenectady, N. Y., has been transferred to the River Works of the company, Lynn, Mass., where he will be engaged in the design of such equipment. He has been with the company since 1936.

T. J. Martin (A'35) formerly electrical engineer, Commonwealth Edison Company, Chicago, Ill., is now with Lockheed Aircraft

Corporation, Burbank, Calif., taking the special training course for engineers being given by that organization in co-operation with California Institute of Technology.

A. S. Albright (M'37) superintendent of meters, Detroit Edison Company, Detroit, Mich., has been appointed acting chief of research, during the absence of Douglas Dow, chief of research, on advisory service to the United States Army.

M. C. Titus (A'39) formerly transit man and acting electrical inspector, Roza project, United States Bureau of Reclamation, Yakima, Wash., is now employed as an assistant engineer by the Bonneville Power Administration, Portland, Ore.

B. F. Thomas, Jr. (A'14, M'29) formerly principal engineer for the Public Works Administration, Washington, D. C., is now employed as electrical and mechanical engineer by the Foundation Company, New York, N. Y.

P. D. Rossiter (A'33) formerly mill electrician for the Britannia Mining and Smelting Company, Ltd., Britannia Beach, B. C., Canada, is now employed as electrical draftsman by the Alberta Nitrogen Company, Calgary, Alberta, Canada.

M. W. Leslie (A'39) formerly teaching assistant at the University of Minnesota, Minneapolis, is now a member of the electrical engineering department, College of Engineering, Wayne University, Detroit, Mich.

K. T. Compton (F'31) president, Massachusetts Institute of Technology, Cambridge, has been awarded the honorary degree of doctor of science by Columbia University.

R. K. Lane (M'37) president, Public Service Company of Oklahoma, and Southwestern Light and Power Company, Tulsa, has been elected president of the Oklahoma Utilities Association.

O. H. Klippel (A'36) formerly electrical draftsman for the United Light and Power Service Company, Kansas City, Mo., is now employed by the Solvay Process Company, Hopewell, Va.

P. O. Weston (A'35) formerly manager of the St. Louis, Mo., office of the Rockbestos Products Corporation, is now Pacific Coast manager with headquarters at San Francisco, Calif.

J. S. Lieb (A'35) formerly representative of Allis-Chalmers Manufacturing Company at New York, N. Y., has been transferred by the company to the patent department at Milwaukee, Wis.

J. G. Barry (A'38) formerly research assistant, Bartol Research Foundation, Franklin Institute, Philadelphia, Pa., is now an instructor in electrical engineering at Princeton University, Princeton, N. J.

John Happy (A'40) formerly employed in the engineering department of the Ohio Public Service Company, Port Clinton, is now with the Swartwout Company, Cleveland, Ohio.

Everett Eberhard (A'39) formerly instructor in electrical engineering, South Dakota State College, Brookings, is now employed in the engineering department of Hobart Brothers Company, Troy, Ohio.

C. F. Myers (A'31) formerly assistant superintendent, central division, Puget Sound Light and Power Company, Seattle, Wash., has been promoted to general engineering, with broader duties.

F. H. Travers (A'26, M'32) is now with the electrical engineering division of the Philadelphia Electric Company, Philadelphia, Pa.

W. M. Allen (A'27) commercial representative, Pacific Telephone and Telegraph Company, has been transferred from Spokane, Wash., to Seattle, Wash.

M. W. Brown (A'34) formerly power dispatcher, P. R. Mallory and Company, Indianapolis, Ind., is now employed by Fairbanks Morse Company, Beloit, Wis.

H. W. Giesecke (A'35) formerly with the Research Corporation, Bound Brook, N. J., is now employed by Celanese Corporation of America, Narrows, Va.

H. V. Scarborough, Jr. (A'38) formerly test man with General Electric Company, is now employed by the Carolina Power and Light Company, Asheville, N. C.

H. L. Miller (A'38) president, Utilities Engineering Company, Philadelphia, Pa., has been elected vice-president of the Electrical Association of Philadelphia for 1941.

F. A. Graham (M'30) former superintendent, power sales, Kansas City Power and Light Company, Kansas City, Mo., has been made manager of power sales.

A. E. Harrison (A'39) is now employed by the Sperry Gyroscope Company, Garden City, N. Y.

Obituary • • •

Charles Augustus Stone (A'91, M'07) cofounder and chairman of the board, Stone and Webster, Inc., New York, N. Y., died February 25, 1941. He was born at Newton, Mass., January 16, 1867, and was graduated from the electrical-engineering course at Massachusetts Institute of Technology in 1888, with the degree of bachelor of science, receiving the honorary degree of master of science from Harvard University in 1914. After working in the research laboratory of the Thomson Electric Welding Company and for the C. and C. Motor Company, he formed a partnership with Edwin S. Webster in 1889, originally under the name of Massachusetts Electrical Engineering Company, Stone and Webster, managers. The firm designed and supervised operation of electric light and power plants and street railways, and later began to assume management of electrical utilities for private owners, subsequently taking over also the management of gas plants, water-supply systems, central steam heating plants, and bus companies. In the early 1900s the firm also undertook the financing of utility companies, and thus entered the investment banking field, where its functions were later taken over by Stone and Webster and Blodget, Inc., of which Mr. Stone was a director. During the World War the organization built the 50-way shipyard at Hog Island, Pa., which served as an assembling plant for shipbuilding, and also built the cantonment at Kelley Field, Tex., and the ordnance base for the American Expeditionary Force in France, as well as other war construction. Mr. Stone was instrumental in the organization in 1925 of the Engineers Public Service Company, for some time a subsidiary of Stone and Webster, Inc., and was its chairman for some years. He was a director of the Federal Reserve Bank of New York, 1919–23, director of various other companies, and member of several technical societies.

William Horatio Freedman (A'90, M'95, F'13) retired electrical consultant, Nyack, N. Y., died recently, according to information just received. He was born at New York, N. Y., December 28, 1867, and after studying at the College of the City of New York, received the degrees of civil engineer, 1889, and electrical engineer, 1891, at Columbia University, and later that of master of science from the University of Vermont. He continued at Columbia as graduate student, tutor, and from 1893 to 1899 as instructor in electrical engineering. During the period 1894–99 he was a member of the firm of Freedman, Rennard, and Company, electrical engineers and contractors. He became professor of electrical engineering at the University of Vermont, Burlington, in 1899, and except for the years 1910–13, when he was head of the department of applied electricity at Pratt Institute, Brooklyn, N. Y., continued at Vermont until 1920. He also carried on consulting practice. Later he was technical employment representative for the American Telephone and Telegraph Company, New York, N. Y., and research engineer for the Bonded Products Corporation, New York, and from 1925 until his retirement several years ago practiced as an electrical consultant and technical writer at Nyack, N. Y. He was also a member of the American Association for the Advancement of Science, the Society for the Promotion of Engineering Education, and the Institute of Radio Engineers.

Jack B. Hill (A'10, M'13) vice-president, American Gas and Electric Service Corporation, New York, N. Y., died January 19, 1941, at Orange, N. J. He was born January 20, 1881, at Jonesboro, Ind., and received the degrees of bachelor of science in electrical engineering, 1905, and electrical engineer, 1922, from Purdue University. He interrupted his college career to enter the apprentice course of Westinghouse Electric and Manufacturing Company at Pittsburgh, Pa., and from 1902 to 1904 was assistant electrical engineer for the Oliver Iron and Mining Company, Eveleth, Minn. After graduation, he spent three years with Union Electric Light and Power Company, St. Louis, Mo., as draftsman and later superintendent of electrical construction on substations. He then returned to Westinghouse for a time as salesman at the Memphis, Tenn., office. In 1909 he became instructor in electrical engineering, University of Iowa, Iowa City, and later assistant professor, remaining on the faculty for 14 years. In 1923 he became vice-president and general manager, Lincoln (Nebr.) Gas and Electric Company, later holding the same position with the Ohio Utilities Company, Columbus, until 1928, when he became assistant to the vice-president in charge of operations, American Gas and Electric Company, New York. He became a vice-president of that company about 1935, and of American Gas and Electric Service Corporation about two years later.

Thomas Witt Fitzgerald (A'15, M'21) head of the department of electrical engineering, Georgia School of Technology, Atlanta, died February 20, 1941. He was born November 16, 1885, at Wolf Creek, W. Va., completed the academic course at Marshall College in 1905, and received the degrees of bachelor of science in mechanical engineering, 1909, and electrical engineer, 1924, from the University of West Virginia, and that of master of science, 1925, from Emory University. He was a student engineer with the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa., 1909–10, and from 1910 to 1912 was employed in the electrical maintenance department of the New River and Pocahontas Consolidated Coal Company. He became an instructor in electrical and mechanical engineering, Michigan Agricultural College, Lansing, in 1912, and in 1914 went to the University of Arizona, where he was assistant professor in charge of the electrical engineering department until 1918. From 1918 to 1920 he was electrical engineer in charge of maintenance and construction for the Ray Consolidated Copper Company, Hayden, Ariz. He had been professor of electrical engineering and head of the department at Georgia School of Technology since 1920. He was also a member of Tau Beta Pi and the Society for Promotion of Engineering Education.

Henry Lumsden Woolfenden (A'17, M'17) retired head of the mechanical-engineering department, Lawrence Institute of Technology, and consulting engineer, Detroit, Mich., died January 19, 1941. He was born July 15, 1874, at Detroit, and received the degrees of bachelor of science in electrical engineering, 1896, master of science, 1897, and electrical engineer, 1904, from the University of Michigan. In 1897 he was employed by Gilbert Wilkes, consulting engineer, Detroit, and in 1899 became a partner. He became treasurer of the firm in 1900 on its incorporation, and in 1901 became president, taking charge of the Denver, Colo., office. In 1905 he was employed by Allis-Chalmers Manufacturing Company as salesman in charge of the power department of the Denver office, and in 1910 became district manager. He continued consulting work during this period. In 1918 he formed the consulting firm of Woolfenden, Wood, and Weber, Denver, practicing there until 1922, when he returned to Detroit to head the Elliot-Taylor-Woolfenden Company, department store. He returned to sales engineering in 1925 and continued until his retirement in January 1940. During this period he also headed the department of mechanical engineering of Lawrence Institute of Technology.

Lawrence J. Montgomery (A'18) manager, special business bureau, sales department, Consolidated Edison Company of New York, Inc., New York, N. Y., died January 21, 1941, at West Palm Beach, Fla. He was born at Susquehanna, Pa., May 30, 1884, and graduated in electrical engineering from Pratt Institute. He was employed in the test department of General Electric Company, Schenectady, N. Y., in the testing laboratories of the New York Edison Company, and by Cowden and De Young, electrical contractors, before entering the power sales department of the New York and Queens Electric Light and Power Company about 1911. He became power agent in 1912, assistant general sales manager in 1917, and general sales manager in 1934. He was transferred to Consolidated Edison in 1937 as manager of the sales technical bureau, and became manager of the special business bureau in 1940.

Wallace Theodore Gill (A'31) vice-president and general manager, Piedmont and Northern Railway, Charlotte, N. C., died January 28, 1941, at Greenville, N. C. He was born at Richland, Fla., September 26, 1886, and attended the University of Florida. He had been in railroad work since 1901, when he was employed as switch tender by the Atlantic Coast Line. He was with the Charlotte Harbor and Northern Railway 1907–08; with the Florida East Coast Railway, 1908–09. In 1909 he became chief clerk and traveling auditor for the Carolina and Northwestern Railway. He had been with the Piedmont and Northern Railway since 1912, becoming assistant to the general manager in charge of operation and maintenance in 1925. He became general manager in 1934, and vice-president in 1935, and also had held those positions with the Durham and Southern Railway since 1935.

Andrew Kenneth Selden, Jr. (A'03) engineering department, Crocker-Wheeler Electric Manufacturing Company, Ampere, N. J., died October 3, 1940, according to information just received. He was born in Jefferson County, W. Va., November 26, 1880, and received the degree of bachelor of science in electrical engineering at the University of Tennessee in 1900. Following graduation he entered the test department of General Electric Company at Lynn, Mass., and in 1902 was transferred to the d-c motor engineering department as assistant engineer. He was later employed by the Electro-Dynamic Company, Bayonne, N. J., for several years. He had been with the Crocker-Wheeler Company since 1912.

Reuben Irving Wright (A'04, M'07, F'13) retired director and chief engineer of the Electric Controller and Manufacturing Company, Cleveland, Ohio, died January 4, 1941. He was born April 10, 1876, at Sedalia, Mo., and received his technical education at the Lawrence Scientific School of Harvard University. He worked as electrical draftsman for the Brown Hoisting Machinery Company, Cleveland, and the Wellman-Seaver-Morgan Company, before joining the Electric Controller and Supply Company in 1900. He was successively draftsman, chief draftsman, assistant engineer, sales engineer, engineer, and eventually chief engineer and a director of the company. He retired in 1920.

Masajiro Yonezawa (A'25) lecturer, Tokyo Technical University, Tokyo, Japan, died February 9, 1940, according to information just received. He was born at Tottori City, Japan, February 14, 1882, and was graduated in 1907 from the college of electrical engineering of the Tokyo Imperial University. He became an electrical engineer for the Japanese Government Railways in 1909 and continued in that capacity until 1932, spending some time in the United States as resident representative, with headquarters in New York, N. Y. He had held his position with the Tokyo Technical University since 1932.

Carl Henry Hoge (A'19, M'29) assistant engineer, Puget Sound Power and Light Company, Seattle, Wash., died January 12, 1941. He was born March 9, 1886, at Wenona, Ill., and received the degree of bachelor of science from the University of Illinois in 1909. He was employed by the Seattle (Wash.) Electric Company and by the Pacific Telephone and Telegraph Company before becoming a distribution engineer for the Puget Sound company in 1914. In 1924 he became construction superintendent, distribution department, and later assistant engineer.

Membership

Recommended for Transfer

The board of examiners, at its meeting on March 13, 1941, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

To Grade of Fellow

Boyce, B. K., vice-president and general manager, New York Telephone Company, New York.
Clarke, H. O., Jr., executive vice-president, assistant general manager, and director, Houston Lighting and Power Company, Houston, Tex.
Hughes, R. H., vice-president and general manager, New York Telephone Company, New York.
Plumb, H. T., consulting engineer, General Electric Company, Salt Lake City, Utah.
Taylor, A. L., dean, school of mines and engineering, University of Utah, Salt Lake City, Utah.
Ward, O. M., superintendent of electrical operation, Wisconsin Electric Power Company, Milwaukee, Wis.

6 to Grade of Fellow

To Grade of Member

Cahill, F. B., designing engineer, General Electric Company, Pittsfield, Mass.
Casey, H. J., assistant safety engineer, Baltimore Transit Company, Baltimore, Md.
Chambers, D. E., assistant engineer, General Electric Company, Schenectady, N. Y.
Cobine, J. D., faculty instructor, Harvard University, Cambridge, Mass.
Jones, H. E., equipment and building engineer, Mountain States Telephone and Telegraph Company, Denver, Colo.
Pearson, H. R., engineer, Dallas Power and Light Company, Dallas, Texas.
Poti, W. M., assistant engineer, New York and Queens Electric Light and Power Company, Flushing, N. Y.
Sanderson, W. D., foreman engineer, Detroit Edison Company, Detroit, Mich.

8 to Grade of Member

Applications for Election

Applications have been recieved at headquarters from the following candidates for election to membership in the Institute. Names of applicants in the United States and Canada are arranged by geographical Districts. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the national secretary before April 30, 1941 or June 30, 1941 if the applicant resides outside of the United States or Canada.

United States and Canada

1. North Eastern

Adams, C. G., General Electric Company, Schenectady, N. Y.
Adams, G. M., General Electric Company, Schenectady, N. Y.
Atkinson, W. R., Northborough High School, Northboro, Mass.
Bardwell, M. W. (Member), Central New York Power Corporation, Syracuse, N. Y.
Barry, L. E., General Electric Company, Schenectady, N. Y.
Bean, W. S., Jr., General Electric Company, Schenectady, N. Y.
Becker, J. A., Jr., General Electric Company, Pittsfield, Mass.
Bendz, W. I. (Member), Westinghouse Electric and Manufacturing Company, Boston, Mass.
Bigbie, D. D., United States Army, 187th Field Artillery, Fort Ethan Allen, Vt.
Black, E. N., General Electric Company, Schenectady, N. Y.
Borkowksi, C. J., Colonial Radio Corporation, Buffalo, N. Y.
Brudzynski, A. J., General Electric Company, Lynn, Mass.
Burton, L. A., General Electric Company, Schenectady, N. Y.
Carriere, C. A., General Electric Company, Schenectady, N. Y.
Chamberlin, J. R., Jr., General Electric Company, Schenectady, N. Y.
Chestnut, H., General Electric Company, Schenectady, N. Y.
Codichini, J. J., Scintilla Magneto Company, Sidney, N. Y.
Comstock, A. N., Connecticut Light and Power Company, Norwalk, Conn.
Crowell, C. D., General Electric Company, Syracuse, N. Y.
Dana, G. E., New York State Electric and Gas Corporation, Binghamton, N. Y.
Delany, F. J., United States Navy Department, General Electric Company, Bridgeport, Conn.
DeVore, T. D., Central New York Power Corporation, Oswego, N. Y.
Dice, J. W., Westinghouse Electric and Manufacturing Company, Syracuse, N. Y.
Faulknor, R. E., Central New York Power Corporation, Potsdam, N. Y.
Freer, G. B., Jr. (Member), Central New York Power Corporation, Syracuse, N. Y.
Gagne, W. N., United States Electrical Motors, Incorporated, Milford, Conn.
Gethmann, R. B., General Electric Company, Bridgeport, Conn.
Hardy, B. B., Aerovox Corporation, New Bedford, Mass.
Higgs, R. E., Factory Insurance Association, Hartford, Conn.
Holmes, L. L., Jr., General Electric Company, Schenectady, N. Y.
Howard, C., Jr., General Electric Company, Schenectady, N. Y.
Hutchinson, R. M., Harvard University Graduate School of Engineering, Cambridge, Mass.
Jarvis, T. F., Warsaw Electric Company, Warsaw, N. Y.
Kellogg, H. L., General Electric Company, Schenectady, N. Y.
Kessler, M. E., International Business Machines Corporation, Endicott, N. Y.
Kilcoin, J. A., Jr., Stone and Webster Engineering Corporation, Boston, Mass.
Kurtz, R. B., General Electric Company, Schenectady, N. Y. (for mail: 37 Washington Place, Ridgewood, N. J.).
Lebenbaum, M. T., Massachusetts Institute of Technology, Cambridge, Mass.
Lerstrup, K. (Member), Tufts College, Medford, Mass.
Levin, K. L., Colonial Radio Corporation, Buffalo, N. Y.
Lewis, D. C., Central New York Power Corporation, Utica, N. Y.
Livingood, H. L., New York State Electric and Gas Corporation, Binghamton, N. Y.
Lloyd, H. R., Jr., General Electric Company, Schenectady, N. Y. (for mail: 1839 Holly Street, Harrisburg, Penna.).
Lynn, W. B., General Electric Company, Schenectady, N. Y.
Mandil, I. H., Massachusetts Institute of Technology Graduate House, Cambridge, Mass.
McMillan, M. V., Buffalo Niagara Electric Corporation, Buffalo, N. Y.
Meranda, J. I., Bethlehem Steel Company, Lackawanna, N. Y.
Meyers, P. A., General Electric Company, Pittsfield, Mass.
Miller, J. F., General Electric Company, Lynn, Mass.
Niebuhr, W. F., Jr., General Electric Company, Schenectady, N. Y.
Nitz, H. I., General Electric Company, Schenectady, N. Y.
Nolan, W. J., Jr., Rensselaer Polytechnic Institute, Troy, N. Y.
Oliver, C. H., Central New York Power Corporation, Utica, N. Y.
Page, J. C., General Electric Company, Schenectady, N. Y.
Papenhausen, R. W., General Electric Company, Schenectady, N. Y.
Pearson, T. J., Jr., Boston Edison Company, Boston, Mass. (for mail: 71 Nesmith Street, Lawrence, Mass.).
Person, K. S., Norton Company, Worcester, Mass.
Personius, K. E. (Member), New York State Electric and Gas Corporation, Elmira, N. Y.
Reuter, J. E., General Electric Company, Pittsfield, Mass.
Roberts, D., General Electric Company, Schenectady, N. Y. (for mail: 43 Fern Street, New Rochelle, N. Y.).
Russ, R. B., General Electric Company, Schenectady, N. Y.
Schlawin, R. G., General Electric Company, Schenectady, N. Y.
Schneider, F. J., Central New York Power Corporation, Fulton, N. Y.
Schnure, R. B., General Electric Company, Schenectady, N. Y.
Schwarz, S. J., Stone and Webster Engineering Corporation, Boston, Mass.
Scott, S. E., United States Army, Camp Edwards, Mass.
Sheridan, E. W., Massachusetts Institute of Technology, Cambridge, Mass.
Sills, R. M., Jr., General Electric Company, Schenectady, N. Y.
Skeirik, R. M., International Business Machines Corporation, Endicott, N. Y.
Sorace, K. J., Rochester Gas and Electric Corporation, Rochester, N. Y.
Steele, R. B., General Electric Company, Schenectady, N. Y.
Stevens, T. H., Central New York Power Corporation, Watertown, N. Y.
Strong, W. F., General Electric Company, Schenectady, N. Y.
Swartwout, D. K., 3rd, General Electric Company, Pittsfield. Mass.
Taylor, C. M. (Member), Central New York Power Corporation, Syracuse, N. Y.
Taylor, G. A., Central New York Power Corporation, Syracuse, N. Y.
Upham, S. W., General Electric Company, Schenectady, N. Y.
Vincent, H. F., International Business Machines Corporation, Endicott, N. Y.
von Sothen, C. E. H. (Member), General Electric Company, Syracuse, N. Y.
Wartinbee, W. J., General Electric Company, Pittsfield, Mass.
Weeks, R., Jr., Electrolux Corporation, Old Greenwich, Conn.
Were, A. E., General Electric Company, Schenectady, N. Y.
Wieser, C. R., Boston Edison Company, Boston, Mass.
Willis, E. W., 341 Warren Street, Needham, Mass.
Wright, R. D., General Electric Company, Lynn, Mass.
Wyrick, L. L., General Electric Company, Pittsfield, Mass.
Zingrebe, O. C., General Electric Company, E. Lynn, Mass.

2. Middle Eastern

Ainsworth, J. L., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Penna.
Akers, H. T., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Allen, D. E., Rural Electrification Administration, Washington, D. C.
Anderson, L. L., Hygrade Sylvania Corporation, Emporium, Penna.
Andreas, J. C., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Arndt, M. H., Westinghouse Electric and Manufacturing Company, Washington, D. C.
Arnett, L. C., Howard University, Washington, D. C.
Askegaard, D. H., Rural Electrification Administration, Washington, D. C.
Astin, J. S., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Penna.
Atkinson, G. D., Jr., Federal Power Commission, Washington, D. C.
Auten, L. D. (Member), Fredericktown, Ohio.
Balog, M., Glenn L. Martin Company, Baltimore, Md. (for mail Box 115, Vintondale, Pa.).
Barbarowicz, W., Pennsylvania Electric Company, Johnstown, Pa.
Barnes, E. C., Reliance Electric and Engineering Company, Cleveland, O.
Bauman, P. A., Rural Electrification Administration, Washington, D. C. (for mail Warrensburg, Ill.).
Bernhart, C. B., Jr., Carnegie-Illinois Steel Corporation, Vandergrift, Penna.
Bichsel, H. J., Westinghouse Electric and Manufacturing Company, E. Pittsburgg, Pa.
Birmingham, W. T., Central Police Station, Traffic Engineering Division, Cleveland, Ohio.
Bobula, L. A., Westinghouse Electric and Manufacturing Company, Forest Hills, Penna.
Brooks, J. D., U. S. Housing Authority, Washington, D. C.
Buck, D. H., General Electric Company, Washington, D. C.
Bunk, J. S., Erie Lighting Company, Erie, Pa.
Burmeister, F. H., Air-Way Electrical Appliance Corporation, Toledo, O.
Calvarese, J. F., RCA Manufacturing Company, Incorporated, Camden, N. J.
Caplan, N., RCA Manufacturing Company, Camden, N. J.
Carter, R. C., United States Coast Guard, Cleveland, Ohio.
Close, R. H., Roller Smith Company, Bethlehem, Pa.
Coleman, R. E., Jr., General Electric Company, Philadelphia, Pa.
Comstock, J. A., Acme Electric and Manufacturing Company, Cleveland, Ohio.
Cooper, H., Campbell Soup Company, Camden, N. J.
Cunningham, J. H., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Deucher, T. F., Ohio Electric Manufacturing Company, Cleveland, Ohio.
Duckwald, C. S., Jr., Ideal Electric and Manufacturing Company, Mansfield, Ohio.
Faulk, D. P., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Feher, L. H. G., Lehigh Structural Steel Company, Allentown, Penna.
Fielder, D. C., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Fields, R. E., Rural Electrification Administration, Washington, D. C.
Fiet, O. O., RCA Manufacturing Company, Incorporated, Camden, N. J.
Freeman, B., Pennsylvania Railroad Company, Pittsburgh, Pa.
Garrett, P. T., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Gill, E. G., Jr., Gill and Simpson Electrical Company, Baltimore, Md.
Gilman, S., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Godard, R. R., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Griswold, A. W., Clark Controller Company, Cleveland, Ohio.
Gulnac, H. D., Bell Telephone Company of Pennsylvania, Philadelphia, Pa. (for mail: 323 Allenhurst Avenue, Ridgway, Penna.).
Gutheim, R. J., Potomac Electric Power Company, Washington, D. C.
Hammell, A. E., Jr., Monitor Controller Company, Baltimore, Md.
Harbage, B., Jeffrey Manufacturing Company, Columbus, Ohio.
Harris, M., 815 Edgewood Avenue, Charleston, W. Va.
Harvey, J. A., Jr., Pennsylvania Electric Company, Johnstown, Pa.
Heckel, R. D., Navy Department, Philadelphia, Penna.
Heinze, L. O., Delco Products Corporation, Dayton, O.
Hower, J. F., American Steel and Wire Company, Cleveland, O.
Hymowitz, H. M., Navy Department, Philadelphia, Penna.
Ide, H. A., Rural Electrification Administration, Washington, D. C.
Ivy, J. G., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
James, E. C., Public Service Electric and Gas Company, Burlington, N. J.
Jenkins, W. L., B. F. Goodrich Company, Akron, Ohio.
Karlsson, C. E. E., E. I. du Pont de Nemours and Company, Incorporated, Wilmington, Del.
Kehl, H. A., Lincoln Electric Company, Cleveland, Ohio.
Keiffer, R. L., General Electric Company, Erie, Pa.
Keirn, G. F., Goodyear Tire and Rubber Company, Akron, Ohio.
Keller, W. B., Cleveland Electric Illuminating Company, Cleveland, Ohio.
Kelley, W. E., Pennsylvania Railroad, Altoona, Pa.
Kennedy, M., Westinghouse Electric and Manufacturing Company, Washington, D. C.
Kerstetter, D. R., Hygrade Sylvania Corporation, Emporium, Penna.
Kirkland, C. W., Jr., Ohio Power Company, Bellaire, Ohio.
Kirwan, J. G., University or Pittsburgh, Pittsburgh, Penna.
Koehler, G. A., Procter and Gamble Company, Ivorydale, Ohio.
Koenig, F. E., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Leon, R. E., Rural Electrification Administration, Washington, D. C.
Levy, T. A., General Electric Company, Philadelphia, Pa.
Linder, F. W., Rural Electrification Administration, Washington, D. C.
Lowy, W. M., Bethlehem Steel Company, Sparrows Point, Md.
Lynch, E., Jr., Pennsylvania Railroad Company, Altoona, Penna.
Manner, C. J., Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.
Marsh, G. H., General Electric Company, Philadelphia, Pa.
Mason, W. S., Albright and Friel Incorporated, Aberdeen, Maryland.
Meeds, L. T., Chesapeake and Potomac Telephone Company, Washington, D. C.
Menapace, R. H., Glenn L. Martin Company, Baltimore, Md.
Menten, R. A., Allegheny Ludlum Steel Corporation, Brackenridge, Penna.
Metz, T. W., Allis-Chalmers Manufacturing Company, Philadelphia, Pa.
Miller, G. M., Bethlehem Steel Company, Bethlehem, Penna.
Morgan, D. E., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.

Moulton, J. F. (Member), Chesapeake and Potomac Telephone Company, Washington, D. C.
Murrie, J. L. (Member), Federal Power Commission, Washington, D. C.
Muszynski, E. L., Philadelphia Company, Pittsburgh, Pa.
Myers, C. S., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Nexon, V. J., Ohio Power Company, Newark, Ohio.
Nims, A. A., Jr., Westinghouse Electric and Manufacturing Company, Baltimore, Md.
Opel, L. G., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Ostrander, W. M., Westinghouse Electric and Manufacturing Company, Cleveland, O.
Panian, R. M., Frigidaire Corporation, Dayton, Ohio.
Payne, S., Lincoln Electric Company, Cleveland, Ohio.
Percy, R. P., Westinghouse Electric and Manufacturing Company, Lima, Ohio (for mail: 648 South 17th Street, Lincoln, Nebraska).
Pettersen, R. A., Pennsylvania Railroad, Altoona, Pa. (for mail: 7 East 17th Street, Brooklyn, N. Y.).
Plotkin, I., Bureau of Ships, Navy Department, Washington, D. C.
Possner, A. W., Jr., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Proctor, V., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Ramsay, J. D., Campbell Soup Company, Camden, N. J.
Raney, J. J., Yale and Towne Manufacturing Company, Philadelphia, Pa.
Reid, G. E., National Tube Company, Ellwood City, Pa.
Reilly, J. E., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Reynolds, P. E., General Electric Company, Philadelphia, Pa.
Rich, E. S., Brush Development Company, Cleveland, Ohio.
Rietzke, E. H. (Member), Capitol Radio Engineering Institute, Washington, D. C.
Rogers, F. C., Rural Electrification Administration, Washington, D. C.
Rogge, R. S., Duquesne Light Company, Pittsburgh, Pa.
Rolfsen, G. A., Western Union Telegraph Company, Cincinnati, Ohio.
Sane, J. H., Republic Steel Corporation, Cleveland, Ohio.
Savage, J. W., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Schimke, C. F., Monongahela West Penn Public Service Company, Fairmont, West Va.
Sebastian, G. C., Philadelphia Electric Company, Philadelphia, Pa.
Shaffer, W. L., The Brown Instrument Company, Philadelphia, Pa.
Shaw, B. W., Potomac Electric Power Company, Washington, D. C.
Shelly, W. M., Pennsylvania Power and Light Company, Hazleton, Pa.
Spencer, D. C., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Penna.
Swickard, E. O., Jr., Calvert Distilling Company, Relay, Md.
Terrant, F. R., Reliance Electric and Engineering Company, Cleveland, O.
Theroux, L. N., War Department, Aircraft Radio Laboratory, Dayton, O.
Thomas, L. A. (Member), Rural Electrification Administration, Washington, D. C.
Towle, E. H., United States Navy, Bureau of Ordnance, Washington, D. C., (for mail: 79 Grant Avenue, Albany, N. Y.).
Unverzagt, P. A., Allis-Chalmers Manufacturing Company, Pittsburgh, Penna.
VanHouten, E. H., United States Army, Fort Dix, N. J.
Verkley, B. M., American Rolling Mills Company, Middletown, Ohio.
Warren, C. E., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Penna.
Wiest, Q. W., United States Government, Maritime Commission, Washington, D. C.
Williams, H. S., Rural Electrification Administration, Washington, D. C.
Willis, A. H., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Wilson, T. L., RCA Manufacturing Company, Incorporated, Camden, N. J.
Winzemer, A. M., Bureau Aeronautics, Navy Department, Philadelphia, Pa.
Woestemeyer, F. B., General Electric Company, Philadelphia, Pa.
Woodall, H. C., Bethlehem Steel Company, Steelton, Pa.
Yetter, J. W., General Electric Company, Philadelphia, Pa.
Zulak, R. R., General Electric Company, Cleveland, Ohio.

3. New York City

Abolin, C. H., Jr., Kenyon Transformer Company, New York, N. Y.
Allen, J. W. (Member), Bendix Aviation Corporation, Bendix, N. J.
Babitt, C. B., Babitt Electric Company, Incorporated, New York, N. Y.
Bailey, M., Sperry Gyroscope Company, Brooklyn, N. Y.
Bayle, A., War Department, United States Government, Brooklyn, N. Y.
Beckman, C., Westinghouse Electric and Manufacturing Company, Bloomfield, N. J.
Benedetti, J., Harry Alexander, Incorporated, New York, N. Y.
Blews, R. R., Jr., Curtiss-Wright Corporation, Caldwell, N. J.
Bowker, M. W., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Brenneman, D. E., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Buonincontri, J., Westinghouse Electric and Manufacturing Company, Newark, N. J.
Burns, T. (Member), American Gas and Electric Service Corporation, New York, N. Y.
Cassidy, B. F. R., Signal Corps Laboratories, Fort Monmouth, Red Bank, N. J.
Crosby, P. F., Public Service Electric and Gas Company, Newark, N. J.
Dyktor, G. J., Long Island Lighting Company, Roslyn Heights, N. Y.
Dziuma, E., Bendix Aviation Corporation, Brooklyn, N. Y.
Eisler, C., Jr., Eisler Engineering Company, Newark, N. J.
Falconetti, S. L., United States Navy, Wright Aeronautical Corporation, Paterson, N. J.
FitzSimmons, L. G., Jr., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Frankel, D. S., Western Electric Company, Kearny, N. J.
Frazier, W. B., Cambridge Instrument Company, Ossining, N. Y.
Graham, W. F., Consolidated Edison Company of New York, Incorporated, New York, N. Y.
Grob, M. P., United States Navy, New York, N. Y.
Grode, J. D., Brooklyn Navy Yard, Brooklyn, N. Y.
Gunzbourg, P. M. (Member), 330 East 56th Street, New York, N. Y.
Hinrichs, J. H., Navy Yard, Brooklyn, N. Y.
Johansson, S. G., Western Electric Company, Kearny, N. J.
Joseph, J. L., United States Army, Signal Corps, Fort Monmouth, N. J.
Kotrbaty, G. F. (Member), E. J. Cheney and Company, New York, N. Y. (for mail: 117 Robbins Avenue, Rockledge, Philadelphia, Pa.).
Kraut, C. F., Ward Leonard Electric Company, Mt. Vernon, N. Y.
Kristensen, M. H., Elastic Stop Nut Corporation, Union, N. J.
McGivney, F. A., M. W. Kellogg Company, New York, N. Y.
Moran, J. M., American Cyanamid Company, Plainfield, N. J.
Moskowitz, S., Industrial Scientific Corporation, New York, N. Y.
Moyer, R. M., Wright Aeronautical Corporation, Paterson, N. J.
Mueller, H., The Liquidometer Corporation, Long Island City, N. Y.
Nye, J. H., Western Union Telegraph Company, New York, N. Y.
Papst, H. W. (Member), Anaconda Wire and Cable Company, Hastings-on-Hudson, N. Y.
Payne, T. A. (Member), New York and Queens Electric Light and Power Company, Astoria, N. Y.
Pegnim, T. C., Sperry Products Incorporated, Hoboken, N. J.
Pettit, J. A., Jr., War Department, Signal Corps, Brooklyn, N. Y.
Plotkin, O., War Department, New York Signal Corps Procurement District, Brooklyn, N. Y.
Pockmerski, D., United States Navy Department, New York, N. Y.
Port, J., War Department, New York Signal Corps, Procurement District, Brooklyn, N. Y.
Post, A. W., Long Island Lighting Company, Roslyn Heights, L. I., N. Y.
Potts, R. M., Parkchester Housing, New York, N. Y.
Pruden, J. H., Westinghouse Electric and Manufacturing Company, Newark, N. J.
Pryzie, J. B. (Member), New York and Queens Electric Light and Power Company, Astoria, L. I., N. Y.
Purgett, L. J. (Member), Bell Telephone Laboratories, Incorporated, New York, N. Y.
Rieke, J. W., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Rudensey, M. B., Federal Telegraph Company, Newark, N. J.
Ruth, J. A., International Business Machines Corporation, New York, N. Y.
Salkind, H., War Department, New York Signal Corps, Procurement District, Brooklyn, N. Y.
Salvatore, V. P., Jr., Central Hudson Gas and Electric Corporation, Poughkeepsie, N. Y.
Savage, N., United States Navy Yard, New York, N. Y.
Schmidt, H. P., Westinghouse Electric and Manufacturing Company, Newark, N. J.
Schreiner, L. R., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Shank, H. M., Consolidated Edison Company of New York, Incorporated, New York, N. Y.
Shaw, L. R., Underwriters' Laboratories, Incorporated, New York, N. Y.
Smith, A., Westinghouse Electric International Company, New York, N. Y.
Soman, R. O., Diehl Manufacturing Company, Elizabethport, N. J.
Tanner, E. G., New York Thread Grinding Corporation, New York, N. Y.
Trench, R. B., New York Telephone Company, New York, N. Y.
Van Zee, W. H., Ocean Accident and Guarantee Corporation, Limited, New York, N. Y.
Walker, A. C., War Department, New York Signal Corps Procurement District, Brooklyn, N. Y.
Warne, C. C., Jr., Hubbard and Company, New York, N. Y.
Warren, J. E., Nilsson Electrical Laboratory, New York, N. Y.
Weston, S., Federal Telegraph Company, Newark, N. J.
Winter, H. F., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Yakman, J. V., Otis Elevator Company, Yonkers, N. Y.
Yingling, G. L., Jr., Underwriters' Laboratories, Incorporated, New York, N. Y.

4. Southern

Alley, R. E., Jr., University of Richmond, Richmond, Va.
Baker, W. W., Memphis Light, Gas and Water Division, Memphis, Tenn.
Bivins, A. C., Jr., Florida Power and Light Company, Miami, Fla.
Blanchard, E. I., Louisiana Power and Light Company, New Orleans, La.
Brice, J. R., Tampa Electric Company, Tampa, Fla.
Delbridge, C. A., Aluminum Company of America, Alcoa, Tenn.
DiVincenzo, A. P., Tennessee Valley Authority, Knoxville, Tenn.
Duling, H. B., Georgia School of Technology, Atlanta, Ga.
Fortune, E. W., Virginia Public Service Company, Clifton Forge, Va.
Fritz, C. J., South Carolina Electric and Gas Company, Parr, S. C.
Gaylord, H. R., Florida Power and Light Company, Miami, Fla.
Gilkeson, W. R., Tennessee Valley Authority, Chattanooga, Tenn.
Hansen, J. W., Jr., Newport News Shipbuilding and Dry Dock Company, Newport News, Va.
Hicks, W. L., Jr., The Le Tourneau Company of Georgia, Toccoa, Georgia.
Higgins, E. W., Georgia Power Company, Augusta, Ga.
Hipp, W. N. (Member), Duke Power Company, Hickory, N. C.
Huber, I. L., Tennessee Valley Authority, Tupelo, Miss.
Jones, L. G., General Electric Company, Jackson, Mississippi.
Kingsland, R. L., Jr., United States Army, 62nd Field Artillery, A.P.O. 37, Camp Shelby, Miss.
Leach, H. R., Chattanooga Electric Power Board, Chattanooga, Tenn.
Petersen, G. C., United States Army, Fort Knox, Ky.
Randle, R. O., Solvay Process Company, Hopewell, Va.
Robinson, J. P., Tennessee Valley Administration, Wheeler Dam, Ala.
Scruggs, D. W., Aluminum Company of America, Alcoa, Tenn.
Shipley, C. S., Tennessee Valley Authority, Chattanooga, Tenn.
Shoaf, J. R., United States Army, Armored Force Replacement Center, Fort Knox, Ky.
Simmons, B., Jr., Western Electric Company, New Orleans, La.
Soniat, E. J., Sewerage and Water Board of New Orleans, New Orleans, La.
Wiggins, C. Q., Jr., Aluminum Company of America, Alcoa, Tenn.
Woods, A. F., Tennessee Valley Authority, Chattanooga, Tenn.

5. Great Lakes

Abolin, T. W., Indiana and Michigan Electric Company, Mishawaka, Ind.
Andermann, R. J., Commonwealth Edison Company, Chicago, Ill.
Anderson, K., Indiana and Michigan Elevator Company, South Bend, Ind.
Anderson, R. E. (Member), Delta-Star Electric Company, Chicago, Ill.
Bauman, C. E., Commonwealth and Southern Corporation, Jackson, Michigan.
Bleaden, S., Goldberg and O'Brien Electric Company, Chicago, Ill.
Brickman, E. A., Western Electric Company, Incorporated, Chicago, Ill.
Burge, W. L., Wisconsin Michigan Power Company, Appleton, Wis.
Cecil, J. B., Wisconsin Electric Power Company, Milwaukee, Wisconsin.
Cohen, J. I., Electromotive Corporation, La Grange, Illinois.
Colby, R. L., Jr., Cutler-Hammer, Incorporated, Milwaukee, Wisconsin.
Cones, V. B., Powers Regulator Company, Indianapolis, Ind.
Davidson, C. S., Yale and Towne Manufacturing Company, Chicago, Ill.
Dembinski, L. J., Fansteel Metallurgical Corporation, Chicago, Ill.
DePew, R. T., Radio Station WGN, Incorporated, Chicago, Ill.
Derus, H. M., Waukesha Motor Company, Waukesha, Wis.
Drummond, V. L., General Motors Corporation, Detroit, Mich.
Firmin, G. P., Indiana and Michigan Electric Company, South Bend, Indiana.
Foxworthy, M. K., Jr., Indianapolis Power and Light Company, Indianapolis, Ind.
Gillis, N. W., Bendix Aviation Corporation, Detroit, Mich.
Griffith, D. J., Eagle Signal Corporation, Moline, Ill.
Haller, P. E., Commonwealth Edison Company, Chicago, Ill.

Hanson, O. E. (Member), Commonwealth Edison Company, Chicago, Ill.
Harris, A. J., Fisher Body Corporation, Detroit, Mich.
Hauber, P. C., United Light and Power Service Company, Davenport, Iowa.
Herman, A. E., Cutler-Hammer, Incorporated, Milwaukee, Wisconsin.
Herrmann, J. A., Bull Dog Electric Products Company, Detroit, Mich.
Hickman, F. J., Eastern Indiana Telephone Company, Winchester, Ind.
Holland, E. B., United Light and Power Service Company, Davenport, Iowa.
Huston, E. F., J. D. Adams Manufacturing Company, Indianapolis, Ind.
Jost, L. J., 2245 E. Kirby, Detroit, Michigan.
Keeler, A. R., 3rd, Walker and Company, Detroit, Michigan.
Kiefert, H. W., Commonwealth Edison Company, Chicago, Ill.
Knudsen, A. L., Navy Department, United States Government, Detroit, Mich.
Kreydich, W., Kellogg Switchboard and Supply Company, Chicago, Ill.
Krug, W. J., Electro-Motive Corporation, La Grange, Ill.
LaHue, D. F., Western Union Telegraph Company, Chicago, Ill.
Leonard, F. M., Illinois-Carnegie Steel Company, Chicago, Ill.
Leske, E. A., Divane Brothers Electric Company, Chicago, Ill.
Major, W. R., Jr., Line Material Company, Milwaukee, Wisconsin.
McLaughlin, D. J., Montgomery Ward and Company, Chicago, Ill.
Otto, H. W., Public Service Company of Northern Illinois, Chicago, Ill.
Parker, L. D., 120 East 13th Street, Traverse City, Michigan.
Rego, D. S., Jr., United States Army Air Corps, Chanute Field, Rantoul, Ill. (for mail: 902 Locust Street, Fall River, Mass.).
Robb, S. J., Commonwealth Edison Company, Chicago, Ill.
Ryan, W. J., Jr., Charlestown Ordnance Construction, E. I. du Pont de Nemours & Company, Charlestown, Ind.
Saltz, L. W., H. E. Beyster Corporation, Detroit, Michigan.
Schall, G. E., Jr., Underwriters' Laboratories, Chicago, Ill.
Sebring, P. B., Zenith Radio Corporation, Chicago, Ill.
Shapiro, H. M., Public Utility Engineering and Service Corporation, Chicago, Ill.
Shay, E., Carnegie-Illinois Steel Corporation, Gary, Ind.
Shouskey, E., 2725—24 Street, Detroit, Mich.
Smale, J. H., Indianapolis Power and Light Company, Indianapolis, Ind.
Spurrell, M. P., Bull Dog Electric Products Company, Detroit, Mich.
Stanford, J. H., Jr., Caterpillar Tractor Company, Peoria, Ill.
Steidinger, D. K., Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin.
Stradling, R. E., Westinghouse Electric and Manufacturing Company, Indianapolis, Ind.
Sullivan, E. F., Zenith Radio Corporation, Chicago, Ill.
Tayler, W. L., Commonwealth Edison Company, Chicago, Ill.
Thompson, C. E., Automatic Electric Company, Chicago, Ill.
Tierney, W. E., Rockbestos Products Corporation, Chicago, Ill.
Tracy, W. F., Illinois Bell Telephone Company, Chicago, Ill.
Wade, S. R., General Electric Company, Fort Wayne, Indiana.
Warnek, R. G., Wisconsin Telephone Company, Madison, Wis.
Weichsel, G. H., Western United Gas and Electric Company, Aurora, Ill.
Weilbaecher, C. O., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Weissert, R. K., General Motors Corporation, Flint, Michigan.
Youngberg, M. D., Commonwealth Edison Company, Chicago, Ill.

6. NORTH CENTRAL

Kettering, C., Fairbanks-Morse and Company, Omaha, Nebraska.
Klosterman, P. C., South Dakota State College, Brookings, S. D.
Kurie, C. W., Jr. (Member), City of Colorado Springs, Colorado Springs, Colo.

7. SOUTH WEST

Armbruster, W. R., Laclede Gas Light Company, St. Louis, Mo.
Ball, W. A., Jr., Gulf States Utilities Company, Beaumont, Texas.
Bohnenblust, C. E., Southwestern Bell Telephone Company, Wichita, Kansas.
Bryant, R. E., Wagner Electric Corporation, St. Louis, Mo.
Chafetz, A. B., City of Austin, Austin, Texas.
Cross, R. K., Emerson Electric Company, St. Louis, Mo.
Dibble, E. F., Grand River Dam Authority, Vinita, Okla.
Dinsmore, J. H., Navy Department, Consolidated Steel Company, Orange, Texas.
Edwards, F. A., Company F, 137 Infantry, Camp Robinson, Little Rock, Arkansas.
Ewan, A. W., U. S. Engineer Office, Little Rock, Ark.
Fell, W. J., Holway and Neuffer, Tulsa, Oklahoma.
Fritsche, L. P., Amerada Petroleum Corporation, Tulsa, Okla.
Hamilton, J. F., Stamolind Oil and Gas Company, Hays, Kansas.
Hobbs, E. G., 349th Field Artillery, Fort Sill, Oklahoma.
Howard, E. L., Texas-New Mexico Utilities Company, Lubbock, Texas.
Hoyt, W. L., Petty Geophysical Engineering Company, San Antonio, Texas.
Kemper, J. T., Wagner Electric Corporation, St. Louis, Mo.
Knaul, J. E., Transcontinental and Western Air, Incorporated, Kansas City, Mo.
Martin, W. G., III, Emerson Electric Manufacturing Company, St. Louis, Mo.
Maxey, W. D., United States Army, 63rd C. A., Ft. Bliss, Texas.
Maze, R. O., Wagner Electric Corporation, St. Louis, Mo.
Metcalf, J. W., Chicago Wilmington and Franklin Coal Company, St. Louis, Mo.
Nafe, H. G., Jr., Century Electric Company, St. Louis, Mo.
Patrick, J. M., Texas-New Mexico Utilities Company, Clovis, New Mexico.
Potthoff, W. J., Emerson Electric Manufacturing Company, St. Louis, Mo.
Ruff, A. S., American Telephone and Telegraph Company, Wichita, Kansas.
Shaw, L. E., S. B. Wadley, Consulting Engineer, Kingfisher, Okla.
Shotliff, L. A., Washington University, St. Louis, Mo.
Sontag, R. E., Okonite Company, St. Louis, Mo.
Vasconcellos, J. A., Jr., 3rd Aircraft Warning Company, United States Army, Fort San Houston, Texas.
White, R. N., Transcontinental and Western Air Incorporated, Kansas City, Mo.
Widell, C. E., Wagner Electric Corporation, St. Louis, Mo.
Wimer, A. G., Jr., United States Engineers, Galveston, Texas.

8. PACIFIC

Ahrens, F. J., Electrical Facilities, Incorporated, Emeryville, Calif.
Allen, H. S., Jr., Photo and Sound, Incorporated, San Francisco, Calif.
Biggs, H. C., General Electric X-ray Corporation, San Francisco, Calif.
Bloom, W. E., Pacific Gas and Electric Company, Oakland, Calif.
Borgeson, L. G., Fox West Coast Theatres, Pasadena, Calif.
Brewer, A. F., Square D Company, Los Angeles, Calif.
Carlton, E. E., Division of Water Resources, Sacramento, Calif.
Carson, D. B., California Institute of Technology, Pasadena, Calif.
Davis, H. S., Lane-Wells Company, Bakersfield, Calif.
Ferry, T. R., Pacific Gas and Electric Company, Shasta County, Calif.
Garretson, H. W., U. S. Navy Department, Mare Island, Calif.
Hamilton, O. W., Signal Corps, United States Army, Hamilton Field, Calif.
Kalb, H. N. (Member), Pacific Gas and Electric Company, San Francisco, Calif.
Keyser, J. H., Jr., Sterling Electric Motors, Incorporated, Los Angeles, Calif.
Kilkenny, J. J., Bethlehem Steel Company, San Francisco, Calif.
Kipp, R. B., Southern California Gas Company, Los Angeles, Calif.
Mann, D. O., Navy Department, United States Government, San Francisco, Calif.
McNulty, C. H., Citizens Utilities Company, Nogales, Arizona.
Moorhead, G. H., Jr., Southern California Gas Company, Los Angeles, Calif.
Mueller, E. H., 903 California Street, Eureka, Calif.
Nelson, N. H., Lockheed Aircraft Corporation, Burbank, Calif.
Pursley, E. M., Westinghouse Electric and Manufacturing Company, Los Angeles, Calif.
Serduke, J. T. (Member), 464 California Street, San Francisco, Calif.
Somerfeld, H., City of Los Angeles, Department of Water and Power, Los Angeles, Calif.
Wells, L. A., Jr., Pelton Water Wheel Company, San Francisco, California.
Witzig, R., Bethlehem Steel Company, Terminal Island, Calif.
Yadon, J. M., Westinghouse Electric and Manufacturing Company, San Francisco, Calif.

9. NORTH WEST

Bryant, W. N., Boeing Aircraft Company, Seattle, Wash.
Chambers, W. R., Washington Water Power Company, Spokane, Wash.
Childers, J. W., Pacific Power and Light Company, Walla Walla, Wash.
Crandall, R. K., California Oregon Power Company, Medford, Oregon.
Hartley, H. E., Idaho Power Company, Emmett, Idaho.
Love, E. B., Idaho Power Company, Caldwell, Idaho.
Lundborg, C. J., Anaconda Copper Mining Company, Great Falls, Mont.
Murphy, T. H., Coast and Geodetic Survey, Seattle, Washington (for mail: 2203 N. Emerson Street, Portland, Oregon).
Nungester, J. L., Washington Water Power Company, Spokane, Wash.
O'Leary, L. R., Puget Sound Power and Light Company, Seattle, Wash.
Ranzenbach, O. F., Washington Water Power Company, Spokane, Wash.
Smith, G. G., Seattle Lighting Department, Seattle, Washington.
Spencer, J. H., University of Washington, Seattle, Wash.
Spillman, W. E., Portland General Electric Company, Portland, Oregon.
Torget, A. O., Boeing Aircraft Company, Seattle, Wash.
Ward-Davis, G., Puget Sound Power and Light Company, Seattle, Washington.
Wiscombe, L. E., Wasatch Oil Refining Company, Woods Cross, Utah.

10. CANADA

Andrews, S. C., Pacific Mills, Limited, Ocean Falls, B. C.
Cline, J. C., Hydro Electric Power Commission of Ontario, Toronto, Ont.
Elliott, H. W., Research Enterprises, Limited, Leaside, Ont.
Fraresso, M., Canadian General Electric Company, Peterboro, Ont.
Gibbons, R. S., Bell Telephone Company of Canada, Toronto, Ont.
Hopkins, H. A., Amalgamated Electric Corporation, Toronto.
Mah, H. G., Canadian Line Materials Limited, Toronto, Ont.
McLean, A. F., Fraser-Brace Engineering Company, Transcona, Manitoba.
Murphy, H. J., Barrie Public Utilities, Barrie, Ont.
Woolgar, C. E. (Member), Northern Electric Company, Limited, Montreal.

Total, United States and Canada, 481

Elsewhere

Andrade, H. Z., Construction Quartermaster, United States Army, Canal Zone.
Craig, D. H. C. (Member), English Electric Company Limited, Bristol, England.
Frugtniet, R. M. L., Johnson and Phillips Limited, Charlton, London, England.
Mayol, F. C., Puerto Rico Telephone Company, Santurce, Puerto Rico.
Purcell, H. C., The Hawaiian Electric Company, Limited, Honolulu, Hawaii.
Setala, V. A., Navy Department, Pearl Harbor, Hawaii.
Smith, J. R., Panama Canal, Balboa Heights, Canal Zone.
Valladares, J. A., Cuban Telephone Company, Havana, Cuba.
Villageliu, A. E., General Electric of Cuba, Edificio "La Metropolitana" Havana, Cuba.

Total, elsewhere, 9

Addresses Wanted

A list of members whose mail has been returned by the postal authorities is given below, with the addresses as they now appear on the Institute record. Any member knowing of corrections to these addresses will kindly communicate them at once to the office of the secretary at 33 West 39th St., New York, N. Y.

Andriessen, Rienk, 54 Division St., Schenectady, N. Y.
Bell, L. W., c/o Marley Mainard, Nogales, Ariz.
Bluethental, Herbert, Jr., 902 Concord Ave., Wilmington, Del.
Brown, Charles A., 14631 Valerio St., Van Nuys, Calif.
Di Addario, Thomas, 3110 Wisteria Ave., Baltimore, Md.
Ernestus, A. W., 137 S. 15th St., Allentown, Pa.
Freed, John H., Olson Construction Co., 410 W. 7th St., Lincoln, Nebr.
Gregory, Herbert Scott, Y. M. C. A., Schenectady, N. Y.
Keller, Ernest Lee, 1303 E. 8th St., Anderson, Ind.
Klatte, A. J., 5505 Agatite Ave., Chicago, Ill.
Kryder, Paul A., 1527 North 52nd., Milwaukee, Wis.
Lancaster, Eugene L., Jr., 646 N. Congress, Jackson, Miss.
Martinez, Joseph D., 550 Florence Ave., Downey, Calif.
McCown, Joe F., 215 Naval Ave., Bremerton, Wash.
Myers, W. H., 505 West Seaside, Long Beach, Calif.
Radcliffe, J. H., 334 Reid St., Peterboro, Ont., Can.

16 Addresses Wanted

Of Current Interest

Electric Power and the National Defense Program

FROM a variety of sources, the following items reflect various aspects of the power supply situation in the United States as it relates to the national defense program.

FEDERAL POWER COMMISSION PREDICTS POWER REQUIREMENTS

In a report recently issued, the Federal Power Commission forecasts probable future requirements for electric power, by power supply areas, through 1942. "In approximately half of the power supply areas," the report states, "there is installed or scheduled for operation this year, sufficient capacity to supply the anticipated demand for 1941. In other areas, it appears that anticipated demands can be met by encroaching on reserves, or by additional capacity made available through interconnections with systems in adjacent areas. In certain hydro areas, the situation can be met if favorable stream flow conditions prevail."

The following conclusions, taken from the report, emphasize the need for continued study and planning to assure the country against shortage of power:

"1. The demand for power is growing more rapidly than the utility systems expected. Their December 1940 demand of 27,752,856 kw exceeded their September 1940 demand by 2,609,154 kw. This increase exceeded by 472,440 kw, or 22 per cent, the estimates in the September reports of the utilities.

"2. In nine important war-material areas (New England, up-state New York, Philadelphia–New Jersey, western Pennsylvania, Ohio, Michigan, Alabama and Georgia, north central Texas, and the Bonneville–Grand Coulee area) the September reports of the utility systems estimated the increase in demand for power for the three following months at 797,806 kw. They experienced an actual increase of 1,223,880 kw, or 53 per cent more than they had estimated. In some of these areas the increases were approximately double those anticipated.

"3. Margins of error of this order in planning to meet power demands two years hence, when the expanding defense program will be pressing the country's generating capacity, would mean serious power shortages such as threatened the defense effort in 1918.

"4. The volume of new capacity on order and the resulting effect on the future net assured capacity is changing rapidly. Between September and December, 1940, the additional generating capacity for installation by December 1942 was increased by 906,500 kw through orders for additional generators, arrangements for expediting existing orders, and orders for new boilers.

"5. Approximately 800,000 kw of capacity in addition to that now on order should be provided by late 1942 to insure against power shortages in a number of areas in that year.

"6. In certain areas, notably New England, Ohio, Missouri, western Wisconsin, and eastern Minnesota, the new orders since September will bring the net assured capacity, as of December 1942, to approximately the level which the estimates of defense load show should be planned for.

"7. In other areas, notably up-state New York and the Georgia–Alabama area, considerable additions to capacity planned for 1942 still fall short of providing sufficient capacity to serve the loads which should be planned for. In the case of New York, increased transmission capacity connecting the up-state systems with the metropolitan area would be of great assistance in meeting the 1942 situation.

"8. The important areas where still further additions to capacity are likely to be needed by December 1942 include those listed above in paragraph 7 and the following areas: Pittsburgh and vicinity, Virginia, Arkansas–Louisiana, and the northern California–Oregon–Nevada area."

Complete copies of the report, which is entitled "Electric Power Requirements and Supply in the United States—December 1940", may be obtained at 50 cents each, from the Federal Power Commission, Washington, D. C.

NETWORK OF LITTLE TVAS PLANNED

Power needs of the defense program are stimulating the efforts of the Government to establish public power development projects, like the Tennessee Valley Authority, in other sections of the United States. An agreement between the United States and Canada on the St. Lawrence seaway and power project was signed at Ottawa March 19, 1941, and is awaiting action by Congress. Legislation now awaiting enactment will provide further development of the Columbia River basin in the northwest, and of the Arkansas River basin in the midwest. An additional appropriation also has been requested for an expansion of TVA activities.

In addition to the activities of these new proposed projects, work is being speeded up and generating capacities increased at other Government power units. Plans are being pushed to rush completion of the Shasta dam project in California, and to provide additional generating capacity at Boulder, Bonneville, and Grand Coulee dams. At Parker Dam, original schedule calls for power generation by 1950, but the first generator is expected to be placed in operation during 1941.

CHAMBER OF COMMERCE COMMITTEE REPORTS ON GOVERNMENT PROJECTS

Opposition to the setting up of regional power authorities in various parts of the country and, more specifically, to the St. Lawrence power project, is expressed in a report by the committee on natural resources production of the Chamber of Commerce of the United States which will be submitted to the membership for consideration at the forthcoming annual meeting of the organization.

The Chamber's committee draws attention to the fact that plans are maturing for the resumption of the regionalization program. In connection with the St. Lawrence seaway and project, on which an agreement with Canada has since been made, the report stated:

"A proposal is also prominent to undertake at once power development on the international section of the St. Lawrence River as a defense emergency measure. More electric power in the St. Lawrence is the primary defense purpose being put forward for this development. For the immediate future and before a new St. Lawrence power project can possibly be completed and ready for operation, new power demands arising in both Canadian and American sections of the St. Lawrence area must be met by other programs.

"It is obvious that the St. Lawrence power project cannot be justified, either in Canada or in the United States, for electric power for defense industries. The growing needs of defense industries in the St. Lawrence region, as elsewhere, are of first importance and they must be met by expansion programs other than the St. Lawrence development now proposed. It is vitally necessary that all additions to present plants should be made as planned and in time to provide electric energy as needed. This need should reach its peak long before new power can be supplied by the proposed St. Lawrence development.

"The companies which have to install the needed additional capacity for the immediate years ahead should be free from apprehension as to the consequent unfair use of government power in ways destructive of investments which are needed for defense."

The committee points out that plans are also under way for the conversion of projects in other areas into regional authorities, including the Columbia River area and the Central Valley in California. It continues:

"Aside from other considerations, it would be unwise at this time, when the country is faced with necessity of heavy outlays for national defense, to divert capital, man-power, engineering talent, construction and manufacturing equipment to projects undertaken ostensibly for national defense that would not afford effective means of meeting present national defense requirements."

In a report on electric power supply, the Chamber's committee finds that by the time defense production goes into high gear existing facilities and additional facilities now planned will be ample to meet all power demands. The committee says:

"Industrial activity in 1940, stimulated by foreign war and home defense, made substantial new demands for electric power from utility systems. Throughout the country these utilities have been able to meet almost every demand with surprising promptness and efficiency. During the year, 1,790,000 kw of new generating capacity were added. The new capacity definitely to be added this year is 3,420,000 kw, exceeding by 1,000,000 kw the greatest previous record in the industry's history, that set in 1930 when 2,490,000 kw were added."

MORE POWER ON PACIFIC COAST

The $30,000,000 Feather River project of the Pacific Gas and Electric Company was approved February 20 by the Federal

Power Commission. Plans call for the construction of two hydroelectric plants to have a combined total capacity of 203,000 horsepower, which is expected to be sufficient to meet any power requirements for the region until the spring of 1945. The new plants will be known as the Cresta and Pulga plants. Work on the former is to begin in one month and to be completed by January 1, 1943; on the latter to be started in six months and to be completed by July 1, 1943. This project is the final link in a $50,000,000 program begun several years ago by the company, and including three steam plants on the bay shore in Contra Costa County, with a combined output of 60,000 horsepower. One of these plants has been completed and the other two are under construction. Work also is in progress on a 28,000 horsepower hydroelectric plant at Dutch Flat in Placer County.

PROGRESS ON SANTEE-COOPER PROJECT

Power production is expected to begin at the Santee-Cooper hydroelectric and navigation project in South Carolina by mid-October 1941. Construction work was begun in March 1932, and the project is being built by the South Carolina Public Service Authority. It includes two dams, one 7 miles long, including a 34,000-foot spillway, and the other 2 miles long. The reservoir will cover approximately 155 square miles.

Strategic Materials and the Defense Program

Government officials are viewing with concern the possibility that American isolation may become an economic fact instead of a theory of foreign policy, according to an article in the February 28, 1941 issue of *United States News*. "In recognition of this possibility," the article continues, "steps are being taken to insure the defense program and American industry an adequate supply of raw materials that now come from abroad.

"Secretary of Commerce Jesse H. Jones has announced plans to build a tin smelter in this country. The President has authorized industry to dip into Government stock piles of tungsten. Ships carrying 25,000 tons of rubber are docking each month at American ports. The Office of Production Management is surveying opportunities for using substitutes for such vital defense metals as steel and aluminum.

Tension in the Orient adds to the worries of procurement officials, for from the Far East come rubber, tin, tungsten, manila hemp, silk, mica, quinine, copra, spices, and vegetable oils. Nearly all of these items are listed as strategic materials by the War Department—materials that are not now obtained from domestic sources. Threatened war with Japan thus raises these questions: Will these vital supplies be shut off, and can American war industries operate if they are shut off?

The fact is that the United States, with the Caribbean area and Canada to draw upon, has little to worry about. American industry and American explorers are finding the answer to most raw material problems. If war should come within the next few months, uncomfortable adjustments might have to be made by civilians, but few doubt that America's war machine could be fed. In the long run, a self-contained America is viewed as distinctly possible."

As part of the program to speed domestic production of tungsten, a research engineer at the Westinghouse Lamp Division, Bloomfield, N. J., makes a test run on domestic tungsten ores.

Training Program of Signal Corps

The Signal Corps of the United States Army is preparing to set in motion at high speed a broad-gauged program of training hundreds of officers and approximately 24,000 enlisted men this year at its Fort Monmouth, N. J. Signal School to form the communications "backbone" of the greatly increased American army now being assembled for national defense, according to an article by Roland C. Davies in the March 1941 issue of *Telegraph and Telephone Age*. The article continues:

"The Fort Monmouth School is the keystone of the Army's training in communications activities since the Signal Corps co-ordinates the communications services for the entire Army and either conducts the instruction activities or trains the officer and noncommissioned personnel of the other branches of the Army to carry on the training programs of the different divisions. Besides the extensive Fort Monmouth School activities, communications training is conducted in the unit communications training centers in each Corps area so as to instruct the specialists and personnel for the Infantry, Cavalry, and Armored Divisions. In each Army area there is also a communications school. The Air Corps, likewise, has its own communications training program and schools which are manned by Air Corps communications officers. But throughout the Army the Signal Corps' operations, methods, and procedure form the foundation for all training activities.

Defense Production Facilities Surveyed

The first interim report on the nationwide survey of portential defense production facilities recently was issued by Walder D. Fuller, president of the National Association of Manufacturers, to the 150 state manufacturers' associations co-operating in the survey. "Plants and machine tools, ready and willing to handle anything from gun boring to parachute manufacture," have been located through the survey, Mr. Fuller reports.

"The majority of the plants now registering their facilities for defense," the report continues, "are not among the 10,000 major corporations already surveyed by Army and Navy departments for possible prime contract purposes; these plants now being revealed are the small contractors who might be geared into this vast production job as subcontractors as quickly as the engineering problems can be solved. . . These manufacturers all over the nation are doing more than sub-contracting defense orders; they are contributing threefold to the stability of our nation during a period of tremendous industrial stress:

"1. By utilizing our existing machine tools, plants, and shipyards, we remove the need for building others, and overexpanding our plant needs.

"2. By making known and ready those tools and yards, contracts may be placed which will employ local labor.

"3. By keeping that labor employed and at home, we will complete the full social and economic advantage to your community, and to the nation as a whole, by eliminating unnecessary migration of labor, and thus, the creation of housing crises."

ASME Discusses Defense. At a joint meeting held March 12–13, in Cleveland, Ohio, under joint auspices of the Army Ordnance Association and various committees and divisions of The American Society of Mechanical Engineers, various aspects of the national defense program were discussed in a well planned and co-ordinated program. Sessions were held on the following topics: Speeding tank manufacture, ammunition manufacture, aviation manufacture, gauging, training and recruitment of industrial personnel, and subcontracting. Papers were presented by representatives of some of the leading manufacturers of defense materials, by representatives of the United States armed forces, and others.

Library Facilities for National Defense. A "Guide to Library Facilities for National Defense" has been prepared by the joint committee on library research facilities for national emergency of the American Library Association. Special, general, and college libraries are included in the 235-page survey of library resources on subjects relating to defense. The material is arranged according to subject, with subdivisions under the main subject headings, and further organized by the geographical location of the libraries. A list of the libraries included, some 500 in number, is appended, as well as an index. The preliminary edition, edited by Carl L. Cannon and published typewritten photolithographic form, may be obtained from the American Library Association, Chicago, Ill.; price $1.25. Plans are in progress for a revised and augmented edition, which it is hoped will appear early in 1942.

Book Lists for Defense Training. A series of book lists to aid in the training of men for defense work has been issued by the American Library Association in co-operation with the United States Office of Education. Five lists have been issued so far on the following topics:

The Shop's Library; Material Useful for Elementary Training, Iva Wintefield.

Industrial Training for National Defense, Charles M. Mohrhardt.

Aeronautic Training for National Defense, Paul Howard.

Engineering Defense Training, Harrison W. Craver and Harrison A. von Urff.

Military Training for National Defense, Florence S. Hellman.

Each list contains outlines of more than 100 books, pamphlets, and periodicals on its particular subject. Copies may be obtained from the American Library Association, Chicago, Ill., at 25 cents each; 10 copies $1.00; 25, $2.00; 50, $3.00; 100, $5.00.

FPC Issues Information on Generating Plants, Power Output

THE Federal Power Commission has issued a directory of electric generating plants in operation in the United States January 1, 1941, with a 27- by 42-inch map of principal generating plants and transmission lines, and also a wall map, $4^1/_2$ by 7 feet. Copies of the wall map, at $2.50 per copy in two sections unmounted, or $5 per copy mounted, and of the directory and smaller map, at $1, may be obtained from the FPC, Washington, D. C. The directory lists all electric utility generating plants in the United States of 1,000 kw or more of installed capacity, classifying them by age, size, and type of prime mover. These 1,922 plants have an aggregate capacity of 39,503,445 kw and comprise more than 98 per cent of total central-station capacity in the United States. A summary of plants classified by states and by types of prime mover is presented in table I.

Information on power production, which reached an all-time high in 1940, also has been issued recently by the Commission. The preliminary estimate of 144,965,000,000 kilowatt-hours far exceeds the highest annual total heretofore recorded and is approximately 11 per cent more than was produced during 1939. Of the total energy reported, 2,719,000,000 kilowatt-hours were produced by electric railroads, electric railways, and other miscellaneous plants.

The production of electric energy by use of water power amounted to 47,742,000,000 kilowatt-hours, or approximately 8 per cent more than was produced by this means in 1939. This represents 33 per cent of the total output for the year. The average for the 21-year period from 1920 to 1940 is 36 per cent of the total.

The total installed capacity of generating plants available for service as of December 31, 1940, was 41,576,000 kw. This represents a net increase of approximately 1,258,000 kw during 1940, or 3.1 per cent more than was reported for the period ending December 31, 1939.

Coal consumption increased approximately 16 per cent, or about 7,000,000 tons.

Oil consumption decreased 4 per cent, or about 700,000 barrels. The amount of gas consumed decreased more than 8,000,000,000 cubic feet, or 4 per cent. From these figures it is apparent that the increased production by use of fuel was accomplished by use of additional coal rather than gas or oil.

Tables II and III show for the United States and its divisions the annual production of electric energy by use of water power and by the use of fuels for the years 1939 and 1940, and the percentage change from 1939 to 1940 in the production of electric energy and the use of different fuels for such purpose. The information in the tables is preliminary and is based on the figures of production of electric energy previously published in the monthly reports issued during 1940. The output of central stations, both publicly and privately owned, electric railway plants, plants operated by steam railroads generating electric energy for traction, Bureau of Reclamation plants, and that part of the output of manufacturing plants which is sold are included in these data. Accurate data are received each month representing approximately 98 per cent of the output shown; the remaining 2 per cent of the output is estimated so that the data represent 100 per cent of the generation.

State Utility Regulation Reported by FPC. A report on "State Commission Jurisdiction and Regulation of Electric and Gas Utilities" has been prepared by the Federal Power Commission to meet administrative needs of Federal state agencies. The data

Table I. Electric Generating Capacity by States, January 1, 1941

(Plants of 1,000 Kw or More)

	Hydro		Steam		Internal Combustion		Total	
States	Number Plants	Total Capacity Kw	Number Plants	Total Capacity Kw	Number Plants	Total Capacity Kw	Number Plants	Total Capacity Kw
Alabama	12	751,283	13	243,810	1	1,528	26	996,621
Arizona	10	291,500	5	49,660	12	40,472	27	381,632
Arkansas	2	65,300	11	72,630	7	10,454	20	148,384
California	97	1,544,617	23	1,157,460	4	44,364	124	2,746,441
Colorado	13	60,310	19	182,285	3	6,209	35	248,804
Connecticut	9	83,250	12	531,340	1	1,100	22	615,690
Delaware			4	23,150	3	3,823	7	26,973
Dist. of Col.			2	305,000			2	305,000
Florida	2	13,713	23	386,038	11	19,161	36	418,912
Georgia	21	335,940	15	137,400			36	473,340
Idaho	25	252,315			1	1,300	26	253,615
Illinois	10	51,893	52	2,559,640	5	9,601	67	2,621,134
Indiana	6	32,710	43	1,259,705	4	8,650	53	1,301,065
Iowa	6	115,900	35	447,970	25	40,425	66	604,295
Kansas	1	3,000	31	434,350	23	35,486	55	472,836
Kentucky	3	110,860	18	246,075	1	1,445	22	358,380
Louisiana			6	368,600	14	27,424	20	396,024
Maine	31	227,823	5	67,000			36	294,823
Maryland	2	271,200	9	399,100	3	4,200	14	674,500
Massachusetts	18	156,291	31	991,840	4	7,743	53	1,155,874
Michigan	60	268,129	26	1,587,575	12	22,766	98	1,878,470
Minnesota	20	116,740	39	424,075	10	15,836	69	556,651
Mississippi			13	46,370	2	3,600	15	49,970
Missouri	5	157,800	29	583,923	16	26,920	50	768,643
Montana	14	313,990	3	10,800	1	1,000	18	325,790
Nebraska	8	132,238	20	221,428	13	19,381	41	373,047
Nevada	5	502,400			1	1,870	6	504,270
New Hampshire	19	226,510	5	80,250			24	306,760
New Jersey			14	1,211,750	1	1,810	15	1,213,560
New Mexico	1	24,300	11	91,430	5	10,590	17	126,320
New York	99	1,111,564	40	3,896,100	4	18,228	143	5,025,892
North Carolina	27	699,591	15	470,250	3	5,200	45	1,175,041
North Dakota			13	79,913	4	5,409	17	85,322
Ohio	4	10,950	68	2,412,865	3	5,292	75	2,429,107
Oklahoma			19	319,102	14	26,074	33	345,176
Oregon	23	376,435	11	171,750	1	2,710	35	550,895
Pennsylvania	9	415,960	68	2,629,927	3	4,895	80	3,050,782
Rhode Island	1	1,000	4	263,700			5	264,700
South Carolina	20	508,860	7	135,800	1	1,458	28	646,118
South Dakota	2	2,500	8	48,850	8	13,713	18	65,063
Tennessee	10	386,253	12	190,690	1	1,183	23	578,126
Texas	15	100,580	44	938,440	25	53,341	84	1,092,361
Utah	20	79,400	2	59,750	3	7,205	25	146,355
Vermont	27	146,490	4	10,400			31	156,890
Virginia	19	172,940	13	385,575	4	5,671	36	564,186
Washington	34	791,112	11	202,570			45	993,682
West Virginia	8	99,640	9	587,440	1	3,200	18	690,280
Wisconsin	34	240,430	27	719,954	6	11,188	67	971,572
Wyoming	5	46,150	8	26,910	1	1,013	14	74,073
Totals	757	11,299,867	900	27,670,640	265	532,938	1,922	39,503,445

Table II. Annual Production of Electric Energy in the United States, 1939 and 1940

(Millions of Kilowatt-Hours)

Geographic Division	Total			By Use of Water Power			By Use of Fuel		
	1939	1940	Change (Per Cent)	1939	1940	Change (Per Cent)	1939	1940	Change (Per Cent)
United States	130,336	144,965	+11	44,022	47,742	+ 8	86,314	97,223	+13
New England	8,350	8,974	+ 7	2,876	2,772	− 4	5,474	6,202	+13
Middle Atlantic	32,970	36,385	+10	7,335	7,721	+ 5	25,635	28,664	+12
East North Central	29,995	33,595	+12	2,883	2,857	− 1	27,112	30,738	+13
West North Central	7,860	8,478	+ 8	1,865	1,694	− 9	5,995	6,784	+13
South Atlantic	15,190	17,623	+16	5,562	5,751	+ 3	9,628	11,872	+23
East South Central	6,968	8,465	+21	5,057	6,055	+20	1,911	2,410	+26
West South Central	6,980	7,435	+ 7	239	319	+33	6,741	7,116	+ 6
Mountain	7,492	8,537	+14	6,017	6,768	+12	1,475	1,769	+20
Pacific	14,531	15,473	+ 6	12,188	13,805	+13	2,343	1,668	−29

Table III. Annual Consumption of Fuels in Generating Electric Energy, 1939 and 1940

Geographic Division	Coal (Thousands of Short Tons)			Oil (Thousands of Barrels)			Gas (Millions of Cubic Feet)		
	1939	1940	Change (Per Cent)	1939	1940	Change (Per Cent)	1939	1940	Change (Per Cent)
United States	46,223	53,405	+16	17,423	16,727	− 4	191,131	183,136	− 4
New England	2,240	2,915	+30	5,282	4,305	−18	0	0	
Middle Atlantic	14,464	16,788	+16	5,025	3,983	−21	4,452	461	−90
East North Central	17,779	20,008	+13	334	424	+27	16,003	12,949	−19
West North Central	3,198	3,611	+13	1,236	1,402	+13	41,572	43,215	+ 4
South Atlantic	5,310	6,466	+22	3,541	3,979	+12	3,681	4,842	+32
East South Central	1,517	1,891	+25	91	162	+78	7,458	6,392	−14
West South Central	929	818	−12	679	750	+10	85,301	91,458	+ 7
Mountain	776	908	+17	630	934	+48	9,503	9,804	+ 3
Pacific	10	0		605	788	+30	23,161	14,015	−39

show the nature and extent of regulation by States under existing laws, and have been checked by the State commissions. Copies of the report, FPC S-10, may be obtained from the Federal Power Commission, Washington, D. C.; price 25 cents.

FPC Reports on Electric Bills. The Federal Power Commission has issued a report showing, in the form of typical net monthly bills, electric rates as of January 1, 1941, for residential, commercial light, commercial power, and industrial service in the 199 cities in the United States with populations of 50,000 or more. Copies of the report may be obtained from the Federal Power Commission, Washington, D. C.; price ten cents.

Positions to Be Filled Through Civil Service Examination

Notice of the following positions, which will be filled through civil service examinations, is published here as a service to members of the Institute. Application forms and full information as to requirements for examinations may be obtained from the secretary of the Board of United States Civil Service Examiners at any first- or second-class post office, or from the United States Civil Service Commission, Washington, D. C.

Chemical Engineers. Various grades, salaries ranging from \$2,600 to \$5,600 a year, less the retirement deduction of $3^1/_2$ per cent. Engineers with experience in strategic mineral research are especially needed by the Bureau of Mines, Department of the Interior. The Regional Research Laboratories of the Department of Agriculture need persons experienced in the industrial utilization of surplus agricultural products. Separate employment lists will be established for positions in various specialized branches of chemical engineering such as fuels, foods, petroleum production, and plastics. Applicants must have completed a four-year college course with major study in engineering. Professional experience in chemical engineering is also required. Appointees will perform engineering work in such fields as pilot plant investigation, design and installation of equipment, and correlation of research data in the specialized branches of chemical engineering in which the appointments are made. Applications will be rated as received at the Commission's Washington office, until further notice.

Co-ordinators of Construction Inspection, United States Maritime Commission. Salary is \$3,800 a year. Applicants may qualify in three optional branches: hull, electrical, and machinery. The maximum age limit is 65. Applicants must have had four years of practical experience of at least journeyman-mechanic grade on the construction or repair of ocean-going vessels. Successful completion of college study in naval architecture or any branch of engineering may be used for part or all of this general experience. An additional four years of experience in supervisory capacity is required. Two years of the total experience must have been gained in construction work on new vessels, while the remaining experience may have been on repair of ocean-going steel vessels. Persons appointed will serve as head of the hull, electrical, or machinery units of the inspection branch of the Maritime Commission. They will act as liaison officers between the home office and shipyards at which vessel construction is under way in order to establish and maintain uniformly high standards of construction and of equipment installation. Applications will be rated as received at the Commission's Washington office until further notice. Qualified persons are urged to apply at once.

Superintendents of Construction. Several grades, salaries ranging from \$3,200 to \$5,600 a year, less a $3^1/_2$ per cent retirement deduction. In general, the duties involve the direction of foremen, laborers, and mechanics on large construction projects. Appointees will inspect materials and workmanship to see that they conform to specifications and will organize men and materials for efficient construction operations. Competitors must have had progressive experience in the field of general construction. Part of this experience must have been as superintendent on large projects involving excavation, reinforced concrete, steel, wood, and masonry, and supervision of three or more foremen of different building or construction trades. Engineering courses completed at a college or technical institute may be substituted for part of the general experience. Applications will be rated as received until December 31, 1941.

Junior Engineers. Positions in any branch of engineering, salary \$2,000 a year, less a $3^1/_2$ per cent retirement deduction. Appointees will perform professional engineering work, including assisting in experimental research, design or testing of machinery, and testing and inspection of engineering materials. Separate employment lists will be established in each recognized branch of engineering. Competitors must have completed a four-year engineering course, except that senior students will be admitted under certain conditions. They will not have to take a written test, but will be rated on their education and will be given additional credit for graduate study in engineering or for engineering experience. Applications will now be rated as received at the Commission's Washington office until December 31, 1941. Qualified persons who do not have eligible ratings under previous junior-engineer examinations held by the Commission within the past year are urged to file their applications at once.

Aeronautical Engineering Inspectors, Navy Department. Salaries range from \$1,620 to \$2,600 a year, less the usual retirement deduction. Maximum age 65 years. Particular attention is called to the experience requirements. In general, applicants must have had experience in the inspection or testing of engineering materials to determine compliance with specifications or standards of manufacture. Mechanical experience such as in the manufacture of precision instruments may be substituted for part of the inspectional experience. Also, each year successfully completed in resident study in an engineering, metallurgical, or technological course may be allowed for part of the experience. There are five optional branches for which the experience need not have been acquired on aircraft work specifically: engines, mechanical parts, instruments, tools and gauges, and materials. Three other options in which persons may qualify are aircraft, aircraft propellers, and parachutes. For all options completion of a training course of the United States Office of Education in materials inspection and testing for making inspection of general mechanical engineering materials will be accepted for one year of the required inspectional or testing experience. Applications will be rated as received at the Commission's Washington office until further notice.

Laboratory Mechanics Experienced in Fuel Rating. Salaries from \$1,620 to \$2,000 a year, less the usual retirement deduction. Appointments will be made at the National Bureau of Standards, Department of Commerce. Responsible experience in the operation, testing, or maintenance of internal-combustion engines including experience in rating fuels with a CFR engine is required. Persons appointed as laboratory mechanics in fuel rating will make routine and referee ratings of motor, aviation, and Diesel fuels using the ASTM-CFR engine, the CFR aviation engine, or the CFR Diesel engine. They will record and tabulate the test data based on their findings. The duties of these positions also include the inspection and overhaul of test engines, and the installation of test equipment. Applications must be filed at the Commission's Washington office not later than April 17, 1941.

Junior Engineering Draftsmen. Salary $1,440 a year. Applicants may qualify in these branches of drafting: aeronautical, architectural, civil, electrical, mechanical (machine design), structural, topographic, lithographic, and general. In addition to completing 14 units of high-school study, applicants must have completed one year's experience or education in drafting, or a course in drafting under the Federal Office of Education Defense Training Program. Applications must be filed at the Commission's Washington office not later than April 24, 1941.

Education • • •

The Biggest Job of American Higher Education

In his Phi Beta Kappa address for 1940 Doctor Robert A. Millikan, president of California Institute of Technology, said: "Let the point be emphasized as strongly as possible that steering students away from an attempt to enter that higher educational system when they do not show any capacity for solving analytical problems with success is not only the most kindly but it is also one of the highest forms of civic duty, since the success of our democracy depends upon it. . . .

"But someone asks, 'What is to be done with the rest?' It is a most amazing thing that in the development of our American educational system so little attention has been paid to the making of any provision for *the apprenticeship training in industry* of our manual and commercial workers who must constitute a large fraction of our population. We are far behind the whole of Europe, England, Australia, and New Zealand in this respect. That is the reason so many of our skilled mechanics and other workers are imported from abroad. Fortunately within the past few years some of our educational agencies have been waking up to this problem, so that what is probably the greatest deficiency in the educational development of the United States is now being given some attention. In consequence what to do with the boy who wants to become a really skilled mechanic is now being attacked through the industrial-apprenticeship plan so well developed in other countries."

Organization of committees of engineers to counsel with high school boys, as a community duty as well as a professional service, is being encouraged by the Engineers' Council for Professional Development.

Radio Interference Conference. To inform radio engineers, service men, amateurs, public service interference "trouble shooters", and others of the sources of radio interference and the possibilities of correction, the University of Illinois, Urbana, is holding a conference May 10, 1941. Topics to be considered by speakers and in panel discussions will include the generation of combination frequencies in a nonlinear element, diathermy interference, receiver design to minimize strong signal interference, interference between radio amateurs and broadcast listeners, adjustment of transmitters to reduce spurious emissions, reduction of appliance interference.

Iowa Management Course. A special three-week course on production planning, time and motion study, and related management problems is being presented for the third time June 9–27, 1941, by the University of Iowa. Planned for executives, engineers, and others interested in such training, the course is under the direction of Ralph M. Barnes, professor of industrial engineering. He will be assisted by six other members of the University faculty and eight visiting engineers and managers who will conduct forums.

Advance Graduation Urged. Graduation of 1942 engineering classes at least three months in advance of the usual date to help supply the need for young engineers in the national defense program was recently advocated by President W. A. Hanley of The American Society of Mechanical Engineers. He suggested that engineering schools continue courses through the summer of 1941 to permit graduation of the class of 1942 in February of that year. (*See also pages 175-7.*)

Other Societies •

Fire Underwriters Celebrate 75th Anniversary

Commemorating the 75th anniversary of the National Board of Fire Underwriters, founded in 1866, a nation-wide program is being planned to emphasize the contributions of fire insurance to national defense and the development of the United States. The program, under the direction of a special committee headed by W. E. Mallalieu, will culminate in commemorative events to be held in New York, N. Y., May 27–28, 1941. A. R. Small (M'37) president, Underwriters' Laboratory, Chicago, Ill., is a member of the national insurance committee co-operating in the effort.

"Recommended Practice of Street Lighting, 1940." The report on recommended street-lighting practice prepared by the committee on street and highway lighting of the Illuminating Engineering Society has been reprinted in bulletin form. The purpose of the publication, as stated, is to furnish the technical basis upon which effective street lighting may be designed, either as a co-ordinated plan for an entire street system or as a plan for any subdivision. Since the variety of conditions encountered makes it impracticable to set up specifications covering all situations, the bulletin is confined to fundamental principles and general specifications. Copies may be obtained from IES headquarters, 51 Madison Avenue, New York, N. Y.; price per single copy, 15 cents, discounts for quantity orders.

Future Meetings of Other Societies

American Institute of Chemical Engineers. Semiannual meeting, May 19–21, 1941, Chicago, Ill.

American Mathematical Society. 379th meeting, May 2–3, 1941, Washington, D. C.

American Physical Society. 241st meeting, May 1–3, 1941, Washington, D. C.

242d meeting, June 20–21, Providence, R. I.

243d meeting (Pacific Coast), June 1941, Pasadena, Calif.

American Society for Testing Materials. 44th annual meeting, June 23–27, 1941, Chicago, Ill.

American Society of Civil Engineers. Spring meeting, April 23–25, 1941, Baltimore, Md.

Annual convention, July 23–25, 1941, San Diego, Calif.

American Society of Mechanical Engineers. Spring meeting, March 31–April 3, 1941, Atlanta, Ga.

Semiannual meeting, June 16–20, 1941, Kansas City, Mo.

Association of Iron and Steel Engineers. Annual spring conference, April 28, 1941, Youngstown, Ohio.

Edison Electric Institute. June 2–5, 1941, Buffalo, N. Y.

Electrochemical Society. Spring meeting, April 16–19, 1941, Cleveland, Ohio.

Illuminating Engineering Society. 2d annual lighting conference, April 25–26, 1941, San Francisco, Calif.

National Electrical Manufacturers Association. May 11–15, 1941, Hot Springs, Va.

National Fire Protection Association. Annual meeting, May 12, 1941, Toronto, Ontario, Canada.

Society for the Promotion of Engineering Education. 49th annual meeting, June 23–27, 1941, Ann Arbor, Mich.

Society of Automotive Engineers. National production meeting, scheduled for May 12–13, 1941, Milwaukee, Wis., has been postponed.

Summer meeting, June 1–6, 1941, White Sulphur Springs, W. Va.

Honors • • • •

J. C. Smith Memorial Medal Founded by Engineering Institute of Canada

The Julian C. Smith Memorial Medal has been established to perpetuate the memory of the late Julian C. Smith (A'88, M'99, F'13), past president of the Engineering Institute of Canada and president of the Shawinigan Water and Power Company. Founded by a group of members of the Engineering Institute of Canada, the medal will be awarded annually for achievement in the development of Canada.

Eight Canadians were selected as initial recipients of the medal, presented at the annual meeting of the Institute February 7, 1941. They were:

Sir Herbert Holt, chairman of the board, Royal Bank of Canada; Beaudry Leman, president, Banque Canadienne Nationale; Augustin Frigon (A'20) assistant general manager, Canadian Broadcasting Corporation; R. J. Durley, former professor of mechanical engineering, McGill University; Honorable C. H. Magrath, former chairman, Canadian section, International Joint Commission; W. D. Black, industrialist, member of executive committee, Bank of Canada; Doctor F. W. Gray, mining engineer, assistant general manager, Dominion Steel and Coal Corporation. A biographical sketch of Mr. Frigon appears on page 181.

1941 Washington Award to Ralph Budd

The Washington Award, conferred annually by a commission representing the Western Society of Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers, and AIEE, has been presented for 1941 to Ralph Budd, president of the Chicago, Burlington, and Quincy Railroad. Bestowed "in recognition of pre-eminent service in advancing human progress," the award was given to Mr. Budd "for vision and courageous leadership in advancing the technological frontiers of high-speed railroad transportation." The John Fritz Medal for 1941 also was awarded to Mr. Budd. In that connection a biographical sketch of him appeared in the December 1940 issue, page 524.

Industry • • • •

Use of Rubber Products in Combating Static Charges

Growing recognition of the importance of the problems created by static charges in such divergent activities as factories, granaries, hospitals, and the oil and aviation industries is reflected in a report on semiconducting rubber and synthetic rubber compounds, prepared by A. E. Juve of the technical department, mechanical division, B. F. Goodrich Company, Akron, Ohio. Highlights of the report follow:

Phenomena associated with the accumulation and discharge of static charges are experienced by everyone. Aside from lightning, the most common experiences are probably the evidences of static charges in combing one's hair, scuffing of the feet on a dry carpet, separating two sheets of paper, and many similar occurrences. These phenomena are usually unobjectionable, though they may be a nuisance and often extremely uncomfortable. In many cases, however, particularly in industry, the discharge of a static accumulation in the presence of inflammable solvents or dust mixtures can be extremely hazardous.

Static charges may be developed in a variety of ways. Primarily, friction between two insulating materials or within an insulating liquid or gas is required. Static charges may also be developed in the absence of friction as when a liquid is broken up into small particles or a mist, or when a mist coalesces into larger particles.

In factories the uncontrolled discharge of static accumulations built up in belts, especially those operating on insulated pulleys, is blamed for an estimated annual fire loss of $3,000,000, according to the National Fire Protection Association.

In aviation the natural flow of air across the body of a plane in flight creates a charge which, if it were not controlled, would reduce the efficiency of de-icing equipment; the same applies to airplane tires.

The turbulent flow of gasoline through hose in loading and delivery operations of the oil industry also creates an obvious danger; while filling stations face a static hazard because automobile bodies become charged in the same way as planes. In this instance the discharge would be particularly hazardous, but for various elementary protective measures adopted widely.

The development of semiconducting rubber and synthetic rubber compounds has been the means of solving a number of important problems involving hazards due to static discharges. Undoubtedly the availability of these materials now will be the means of solving many more.

Some of the applications in which conductive rubber already is being utilized are the following:

(*a*). V-belts for washing machines utilizing a conducting cover which prevents a difference in potential between the motor and the washer from building up.

(*b*). Treads for airplane tires which on landing provide a path for the grounding of the charge accumulated on the plane during flight.

(*c*). Conducting surface on Goodrich de-icer to bleed off to the metal wing structure the static generated during flight, thus preventing a discharge which might puncture the air tubes of the de-icer and reduce its efficiency.

(*d*). Gasoline hose nozzles of conducting synthetic rubber to discharge static existing on cars when they come into the station, as well as the charges generated by the turbulent flow of gasoline.

(*e*). Rubber products, such as mats, heels and soles, sheeting, anesthesia tubing, masks, etc., in hospital operating rooms to eliminate the danger of static discharges igniting anesthetics.

"Two Per Cent for Research." Industrial research is the United States' best insurance against post-war depression, according to a report entitled "Two Per Cent for Research", issued by the National Association of Manufacturers and prepared by Doctor Karl T. Compton (F'31) president of Massachusetts Institute of Technology and chairman of the NAM advisory committee on scientific research. A survey of the research budgets of manufacturing companies showed that two per cent of gross sales income is spent for research by a typical company in a normal year. "If all American industry spent two per cent of gross sales income for research, there could be mobilized in America a quarter of a million scientists and engineers and a billion dollars a year for the development of new goods, new services, new industries, new jobs, and new sources of wages and salaries," Doctor Compton's report declares.

B. M. Tassie Returns to Pacific Coast. A leading executive in the electric appliance industry for the past decade, and closely associated with the industry for a quarter-century, B. M. Tassie has been appointed manager of appliance sales for the newly consolidated Pacific district of the General Electric appliance and merchandise departments, with headquarters in San Francisco. For the past ten years Mr. Tassie has been president of Manning Bowman and Company, electric appliance manufacturers, an organization with which he became affiliated in 1915 as Pacific Coast district manager, with headquarters in San Francisco. Becoming vice-president in 1930, he moved to the company's headquarters in Meriden, Conn., and shortly afterward was elected president. For the past five years he has been a member of the board of governors of the National Electrical Manufacturers Association, and has served on many industries' committees.

Westinghouse to Hire Graduates, Despite Draft. Engineering college seniors interested in working for the Westinghouse Electric and Manufacturing Company will be considered for positions on their merits, regardless of draft numbers or commissions, according to recent announcement. Continuing the policy of interviewing some 2,500 college seniors annually, in co-operation with administrators of accredited colleges, the company expects to select at least 200 of these to enter its employ during the summer and fall. If any of those hired are called up for military training, a deferment plan will be worked out if possible, the company's announcement stated. After a year with the company, the men will be eligible for a year's leave of absence for training, after which they can return to their positions.

Diesel-Electric Freighter for Sante Fe. Following tests of the Diesel-electric freight locomotive completed by Electro-Motive Corporation in 1939, the Santa Fe Railroad ordered a 5,400 horsepower locomotive, which went into regular freight service during February 1940. It consists of two 2,700 horsepower units, each with two 16-cylinder two-cycle engines rated at 1,350 horsepower, and is designed to haul 100 loaded cars on level track at 75 miles per hour, as compared with standard speeds of over 100 miles per hour for passenger Diesel-electrics. Advantages claimed for Diesel-electrics over steam locomotives include fewer service stops, making faster freight schedules possible, and operation during a larger share of time, increasing locomotive miles per year even at identical speeds.

Indiana Transmission Lines. The engineering department of the State of Indiana has prepared a map of the electric transmission lines within the state. Blue line prints of this map, which is 42 by 72 inches in size, may be obtained from The H. Lieber Company, Indianapolis, Ind.; price, $1.25. A limited number of smaller reprints of the map are available for free distribution and may be obtained from the Engineering Department, Public Service Commission, State of Indiana, Indianapolis.

Cashew Varnish. An insulating varnish of the phenolaldehyde type, in which the natural phenol obtained from the outer shells of cashew nuts is used, has been developed by the Irvington Varnish and Insulator Company, *Business Week* reports (March 1, 1941). Since the varnish dries from the inside by heat-induced polymerization, it is adapted especially for the impregnation of large electric coils insulated with asbestos or Fiberglas.

Letters to the Editor • • •

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers; publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Total Security—A Challenge

To the Editor:

Do we accept the challenge?

I have read with great interest and pleasure the address, "Total Security—A Challenge", by Charles E. Wilson, president, General Electric Company, published in Electrical Engineering, March 1941, pages 99–105.

Engineers have pioneered in leading the world to its present heights of technical and mechanical achievement. Through the application of the same vision and determination, they can help to lead the way to "total security".

We, as engineers, must accept this challenge in the same spirit of national service emphasized by Mr. Wilson.

I feel that it is our individual responsibility to mine out the leaders among like-minded men for this new pioneering under Mr. Wilson's leadership. We all can help to mobilize these men in our own Sections. They may be in our plant, office, or community. Everywhere in our ranks are the men whose ideas can produce "total security". It won't happen by chance—it can happen through our individual co-operation.

Murray F. Skinker (F'34)

(Associate director of research, Consolidated Edison Company of New York, Inc., Brooklyn, N. Y.)

(*Editor's Note:* The exchange of ideas through these columns *could* lead to helpful suggestions as to how to develop and implement Mr. Wilson's outlined program of total security.)

A Simple Method of Calculating Power Factor

To the Editor:

The November 1940 issue of Electrical Engineering contained a very interesting letter by Troy D. Graybeal in which he describes a simple method for the calculation of power factor. The method involves the use of a slide rule having an inverse *C* (or *CI*) scale, in addition to the standard *A*, *B*, *C*, and *D* scales.

Since a great many engineers are still using slide rules having only the four standard scales, the following alternative method for the calculation of power factor is suggested.

Using the form and nomenclature of Mr. Graybeal's letter, Let

P = active power in kilowatts
Q = reactive power in kilovolt-amperes
PF = power factor

METHOD

1. Set Q on the *C* scale opposite P on the *D* scale (as before).

2. Note reading on the *A* scale opposite the index of the *B* scale. This reading is equal to $(P/Q)^2$. Since P/Q and also its square may be either greater or less than unity, the decimal point must be located carefully (as before).

3. As in the case of the original method, add unity (1.00) to the reading to give the value $1+(P/Q)^2$. Set this value on the *B* scale opposite the $(P/Q)^2$ reading on the *A* scale. The resultant reading on the *A* scale (opposite index of *B* scale) is equal to $(PF)^2$.

4. Set the indicator to the reading $(PF)^2$ and read the power factor PF at the indicator hairline on the *D* scale.

THEORY

Since the expression for power factor is:

$$PF=\frac{P}{\sqrt{P^2+Q^2}}=\frac{(P/Q)}{\sqrt{1+(P/Q)^2}}$$

it follows that by squaring both sides of the equation:

$$(PF)^2=\frac{(P/Q)^2}{1+(P/Q)^2}$$

we obtain an expression equal to the resultant value of step 3.

Then $PF=\sqrt{\frac{(P/Q)^2}{1+(P/Q)^2}}$ = the result obtained in step 4. By way of illustration let us take example 1 of the original method:

$P=4{,}000$ kw
$Q=3{,}000$ kva (reactive)

1. Set 3,000 on scale *C* opposite 4,000 on the *D* scale.
2. Read 1.78 on scale *A* opposite the left-hand index of scale *B*.
3. Unity added to 1.78 is 2.78. Set 2.78 on the *B* scale opposite 1.78 on the *A* scale and note the resultant value of 0.64 on the *A* scale.
4. Set the indicator to the 0.64 reading on the *A* scale and read $PF=0.800$ on the *D* scale.

Frank Smith (M'38)

(Equipment engineer, Teleregister Corporation, New York, N. Y.)

The Application of Electricity for the Auxiliaries of Railroad Trains

To the Editor:

With reference to the paper by J. E. Gardner on "The Application of Electricity for the Auxiliaries of Railroad Trains" (*AIEE Trans., Jan. '41, p. 34*) it is interesting to attempt an economical design for power to a long train, say 12 cars. Based on the figure of 45 kw per car quoted in the paper, the total for the train would range between 350 and 500 kw depending on whether or not steam is used for heating. It is desirable from the standpoint of fuel economy to relieve the locomotive from the generation of steam for this auxiliary power, so suggestion is made of a condensing turbogenerator set with extraction of low-pressure steam for car heating and an automatically controlled boiler, all located in a special power car or in a baggage car. The transmission of this power along the train at low voltage would result in feeder cables of 2,000,000 circular mils cross section, which would not be practical in the flexible connections between cars; not to speak of carrying the cables under the car floors. Cable sizes at three phase 60 cycles 550 volts, however, would be entirely feasible with appliances already developed. Five hundred and fifty volts is a standard apparatus voltage. A refinement leading to a small reduction in cable sizes and costs would be to raise the voltage, without increasing the amount of insulation, to 600 volts as permitted by the National Electrical Code or to somewhere between 650 and 700 volts as governed by motor and generator coil wrappings. The machines furnished for train use would be special in mechanical features anyway, so that raising the voltage a little should not add to the cost. At each car there would be a transformer stepping down to 120/208 volts four wire three phase, or, if a storage battery is demanded, to a motor generator set with induction motor and d-c generator. On account of constant speed and 60-cycle frequency, and also because the speed could be high, this unit would be small, light, and relatively inexpensive. The air-conditioning compressor could be driven by a standard motor or possibly by mechanical drive from the motor generator set. All mechanical drives from car axles would be eliminated. Normally power would be supplied from the turbogenerator set ahead but for occasions when it could not be used, as at underground stations where sleeping cars are on the tracks some time before the train leaves, power might be supplied from three-phase 220-volt outlets along the track with portable air-cooled transformer units to step up from 220 to 550 or 650 volts, whatever is used, or the turbogenerator might be provided with a motor fed from the trolley or third rail. A further possibility is to mount a 400- or 500-kw motor-generator set on the electric locomotive which would be used in such places.

Such a system, eliminating generation of auxiliary power by the locomotive and doing away with mechanical drives at the cars, and made up of units of high efficiency, should compare favorably in first cost with the present apparatus, and may be expected to show low fuel and maintenance costs.

Selby Haar (A'07, M'13)

(Assistant electrical engineer, Board of Transportation, City of New York, N. Y.)

Matrices in Engineering

To the Editor:

A point of interest regarding the solution of the discriminant matrix for the transient roots of a set of simultaneous differential equations representing a linear network has come to the attention of the writer. It is based on the article by Louis Pipes in September 1937 Electrical Engineering (AIEE Transactions), pages 1177–90. Doctor Pipes points out (page 1188) that one of the roots for the transient solution of the equations of such a network can be evaluated by a simple matrix transformation as follows: The matrix is represented in the form

$$\omega^2[L]-1/\omega[1/C]=[Z]$$

Doctor Pipes obtains the expression for the transient ω in the form

$$\omega^2[I]-[L]^{-1}[1/C]=0$$

as the equation to be solved. This yields, on application of his root-squaring method as outlined in that paper, the root having the greatest value of ω.

It is equally simple to evaluate the root having the smallest value of ω in an exactly similar manner. In this case, one substitutes for ω the value $1/\mu$. Then we have the equation in the form

$$\mu[1/C]-1/\mu[L]=0$$

Solving for μ, we obtain

$$\mu^2[I]-[1/C]^{-1}[L]=0$$

Then again application of the root-squaring method will yield a second root. In this case, as in the previous case, the ratio of the currents in the various meshes is evaluated in the final matrix resulting from the operation of root-squaring. The root obtained by this operation, as stated, is the smallest root of the matrix.

In the case of a problem involving two meshes only, however, the method simplifies further. If we examine the matrices $[1/C]^{-1}$ and $[L]^{-1}$, we notice that their values are just the original matrices with the rows interchanged and the columns interchanged divided by the value of the determinant of the matrix. Carrying out the operation of solving for ω and μ, we find that the only difference in the values of the two is the fact that ω is divided by the determinant of $[L]$, and μ by the determinant of $[1/C]$. Therefore, the ratio of the two roots can be evaluated. We see from this evaluation that if we know one root, it is very simple to determine the other, merely by multiplying and dividing the values of the determinants by the proper numbers. Evaluation of this also shows that the ratio of the transient currents for the two roots has the same magnitude, but the large current for one root is the small for the other. It is perhaps best to consider an example or so in order to demonstrate the value of this simplification.

Take the matrix

$$[Z]=\begin{pmatrix}(4\omega^2+10^4) & 3\omega^2\\ 3\omega^2 & (3\omega^2+10^4)\end{pmatrix}$$

Here

$$D_L=3$$
$$D_c=1\times10^8$$

Then

$$[\omega^2]=[L]^{-1}\left[\frac{1}{C}\right]=\frac{1}{3}\begin{bmatrix}3 & -3\\ -3 & 4\end{bmatrix}\begin{bmatrix}10^4 & 0\\ 0 & 10^4\end{bmatrix}=\frac{10^4}{3}\begin{bmatrix}3 & -3\\ -3 & 4\end{bmatrix}=[R_0]$$

(by definition)

Multiply R_0 by matrix $\begin{bmatrix}1\\1\end{bmatrix}$

$$[R_1]=[R_0]\begin{bmatrix}1\\1\end{bmatrix}$$

Define

$$[R_j]=[R_0][R_{j-1}]$$

Then, by Pipes' rule,

$$\omega^2=\lim_{j\to\infty}\frac{R_j}{R_{j-1}}$$

$$R_{j+1}=\omega^2\cdot K\begin{bmatrix}-0.848\\ 1.000\end{bmatrix}$$

K is product term resulting from $[R_0]^j\begin{bmatrix}1\\1\end{bmatrix}$

In this problem

$$\omega^2={}^1/_3\times6.54\times10^4=2.18\times10^4$$

$$\frac{I_1}{I_2}=\frac{-0.848}{1.000}$$

Solving for μ^2 in like manner,

$$[\mu^2]=\frac{1}{10^8}\begin{bmatrix}3 & 3\\ 3 & 4\end{bmatrix}\begin{bmatrix}10^4 & 0\\ 0 & 10^4\end{bmatrix}$$

Evaluating μ^2,

$$\mu^2=\frac{6.54\times10^4}{10^8}=6.54\times10^{-4}$$

$$\frac{I_1}{I_2}=\frac{1.000}{0.848}$$

Hence, if we write D_c as a, and D_L as b, we have, calling the $6.54\times10^{+4}$ the reduction factor c,

$$\omega^2=c/D_L=c/b$$
$$\mu^2=c/D_c=c/a$$

We must remember here that

$$\mu=1/\omega_0$$

This can easily be shown to be true in general, if one will call

$$[L]=\begin{pmatrix}a & b\\ c & d\end{pmatrix}$$

and

$$[1/C]=\begin{pmatrix}e & f\\ g & h\end{pmatrix}$$

Evaluation of ω and μ from these equations will be found to verify the conclusions stated.

Owing to the fact that the inverse of a matrix of higher than second order does not consist of a simple rearrangement of the original matrix, this does not hold true in general.

KEATS A. PULLEN, JR. (Enrolled Student)

(Graduate school, Johns Hopkins University, Baltimore, Md.)

Books Received •

"Practical Electricity for Home Study." This four-volume set of books, totaling something more than 1,100 pages, is intended, as the name implies, to serve as a home-study text for those of at least high-school level of ability, who desire to attain something of a practical working knowledge of electricity and its more common applications. The material embraced has been used as by the author, Frederick C. Raeth, in his Canadian School of Electricity in Montreal, as the subject matter for both classroom and correspondence courses. The series presents in simple language most of the essential basic principles of electricity, largely in the chronological order in which they were developed, ranging from the voltaic cell to the simpler typical industrial and commercial applications. The manner of presentation is that of a series of graded lessons generously illustrated to facilitate an understanding of the subject matter and supplemented by separate test questions intended for use by the student in progressively testing his understanding. Published by D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y.; per set $8.95.

International Electrotechnical Vocabulary, Spanish Edition. Completion of a Spanish version of the six-language electrotechnical vocabulary developed by the International Electrotechnical Commission has been announced by the Argentine Electrotechnical Committee to the American Standards Association. The Spanish edition maintains the idioms and numerical order of the original (*EE, Jan. '41, p. 54*) but presents the definitions in Spanish instead of in English and French. Translation of the terms alone is given also in German, Italian, French, English, and Esperanto. Copies of the 302-page work may be obtained through the American Standards Association, 29 West 39th Street, New York, N. Y.; price $2.50.

"How America Lives". A study of the living habits of 16 American families, whose incomes range from $100,000 a year to the $26 annual cash income of a sharecropper, has been developed by J. C. Furnas and the staff of the *Ladies' Home Journal*, from actual interviews with the families described. Household equipment, including electric devices, is featured in the studies, along with food, clothing, amusements, and family relationships, and considerable emphasis given to the inadequacy of much American housing in all income brackets. Chosen as one of the typical families were a young engineering graduate and his wife, living on his $33.32 weekly salary as a General Electric testman. Summarizing reports by the editors follow the case studies of individual families, which were published in the monthly issues of the magazine. Published by Henry Holt and Company, New York, N. Y.; price $3.00.

"Vacuum-Tube Voltmeters." This book, by John F. Rider, is intended as a practical exposition of the numerous types of such measuring devices, to serve as a convenient source of information for the engineer, student, and service man. The text covers principles of construction as well as of operation, and presents information drawn from many sources, as well as the author's own compilation of information on the subject. A bibliography of 145 references to articles variously published on vacuum-tube voltmeters and their uses is given. Published by John F. Rider Publisher, Inc., 404 Fourth Avenue, New York, N. Y.; 179 pages; illustrated; price $1.50.

Handbook of Chemistry and Physics. The 24th edition of this standard handbook includes new tables of physical constants of industrial organic compounds and of induced radioactivities, and revision of the table on physical constants of organic compounds, adding about 300 new compounds, and of those on properties of commercial plastics, and on gravimetric factors and their logarithms, in addition to other revision. Contains 2,664 pages; published by the Chemical Rubber Company, Cleveland, Ohio, 1940.

The following new books are among those recently received at the engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ATM (Archiv für technisches Messen). 103, 104, 105, January, February, March, 1940. R. Oldenbourg, Munich and Berlin. Pages T1–36, F1–2, illustrated, 12 by $8^1/_2$ inches, paper, 1.50 rm. each. Three numbers of a monthly publication containing classified articles upon various types of apparatus and methods for technical measurements. Certain numbers also contain descriptions of specific instruments manufactured by German companies.

BAUGHMAN'S AVIATION DICTIONARY AND REFERENCE GUIDE, AERO-THESAURUS. By H. E. Baughman. First edition, second printing. Aero Publishers, Inc., Glendale, Calif., 1940. 598 pages, illustrated, $9^1/_2$ by 6 inches, leather cloth, $5.00. Contains a wide variety of information for those engaged in aviation. Includes a dictionary of aeronautical terms, and the regulations of the Civil Aeronautics Authority which concern students. The information upon occupations, drafting, lofting procedure, shop mechanics, and materials is extensive and practical. Flight maneuvers are illustrated by diagrams. Among other data given are tables of specifications and of needed mathematical data and directories of periodicals, house organs, publishers, clubs, societies, manufacturers, and schools.

AIRCRAFT ENGINES. Volume I. By A. W. Judge. D. Van Nostrand Company, New York, 1940. 380 pages, illustrated, 9 by $5^1/_2$ inches, cloth, $5.50. Endeavors to present the principles and results of relevant research work upon internal-combustion engines, for the benefit of those entering or already engaged in aircraft engineering work, and also is intended to fill a gap existing in aeronautical literature between the more advanced specialist books on theory and design and the elementary descriptive ones on aircraft engines, maintenance, etc. Bibliography.

AIRCRAFT DIESELS. By P. H. Wilkinson. Pitman Publishing Corporation, New York and Chicago, 1940. 275 pages, illustrated, $9^1/_2$ by 6 inches, cloth, $6.00. Outlines the basic principles upon which the Diesel engine functions and the phases and processes involved. Describes fuel-injection equipment, superchargers, and accessories, and the construction of different types of engines. Standardized pages of data are provided. Discusses also the development and mass production of Diesels in Germany and their commercial utility.

INTRODUCTION TO ABSTRACT ALGEBRA. By C. C. MacDuffee. John Wiley and Sons, New York, 1940. 303 pages, diagrams, etc., 9 by 6 inches, cloth, $4.00. Planned for a year's course, with problems furnishing laboratory material and concrete instances of the abstract concepts. The subject is developed logically from the system of rational integers to linear associative algebras. A selected body of facts from number theory, group theory, and formal algebra is offered, to provide a background for the generalized facts of abstract algebra.

RADIO AMATEUR'S HANDBOOK, 18th edition, 1941. American Radio Relay League, West Hartford, Conn. 552 pages, illustrated, 10 by $6^1/_2$ inches, paper, $1.00, buckram, $2.50. Covers comprehensively the amateur short-wave field. The fundamental principles and the design, construction and operation of transmitting and receiving apparatus are described in detail, including ultrahigh frequency, emergency, and portable equipment. Many new illustrations and descriptions of new equipment have been added, and the catalog and manufacturers data section has been expanded.

TIME AND MOTION STUDY AND FORMULAS FOR WAGE INCENTIVES. By S. M. Lowry, H. B. Maynard, and G. J. Stegemerten. Third edition, McGraw-Hill Book Company, New York and London, 1940. 432 pages, illustrated, $9^1/_2$ by 6 inches, cloth, $5.00. This textbook presents the principles and methods of making time and motion studies and constructing time formulas, as a guide for the factory executive. The organization and supervision of time-study, formula, and wage-payment work are outlined. The present edition has been revised to place greater emphasis on methods-study and leveling procedure.

MAGNETISM AND VERY LOW TEMPERATURES. By H. B. G. Casimir. University Press, Cambridge, England; Macmillan Company, New York, 1940. 93 pages, charts, tables, $8^1/_2$ by $5^1/_2$ inches, paper, $1.40. An account presented originally in lectures, of the field of research dealing with the relation between magnetism and very low temperature states. Special attention is given to paramagnetism and adiabatic demagnetization. List of references.

MATERIALS HANDBOOK. By G. S. Brady. Fourth edition. McGraw-Hill Book Company, New York and London, 1940. 591 pages, charts, tables, $9^1/_2$ by 6 inches, leather cloth, $5.00. The many materials used in industry are identified and described. Information is given on physical and chemical properties, constitution, and uses. Ranges from basic raw materials such as mineral ores and woods to such products as alloy steels and synthetic resins. Intended primarily for purchasing agents and industrial executives, its field is much wider for reference use. Tables are appended.

MECHANICAL VIBRATIONS. By J. P. Den Hartog. Second edition. McGraw-Hill Book Company, New York and London, 1940. 448 pages, diagrams, etc., $9^1/_2$ by 6 inches, cloth, $5.00. Includes both theory and practical applications to water wheels, steam turbines, automobiles, airplanes, Diesel engines, and electrical machinery. Revised in accordance with recent developments, many new problems added, and list of formulas appended. Bibliography.

PUBLIC UTILITIES AND THE NATIONAL POWER POLICIES. By J. C. Bonbright. Columbia University Press, New York, 1940. 82 pages, 9 by $5^1/_2$ inches, cloth, $1.25. Discusses control of public utilities, rate regulation, holding companies, and other aspects of Federal policies, and their relation to the question of public ownership. Suggestions for further reading are given.

SALES ENGINEERING. By B. Lester. John Wiley and Sons, New York, 1940. 200 pages, diagrams, 9 by $5^1/_2$ inches, cloth, $2.00. Defining sales engineering as the art of selling equipment and services that require engineering skill in their selection, application, and use, the author discusses its field, the work of the sales engineer under current conditions, and his training and development.

STATISTICAL PROCEDURES AND THEIR MATHEMATICAL BASES. By C. C. Peters and W. R. Van Voorhis. McGraw-Hill Book Company, New York, 1940. 516 pages, diagrams, etc., $9^1/_2$ by 6 inches, cloth, $4.50. Designed to bridge the gap between elementary courses and the original monographic contributions which are often so highly mathematical. The authors bring together and synthesize the classical statistics and certain new developments, explaining mathematical derivations and their use for students with little mathematical training. Exercises and references accompany each chapter.

STEAM-TURBINE PRINCIPLES AND PRACTICE. By T. Croft, revised by S. A. Tucker. Second edition. McGraw-Hill Book Company, New York, 1940. 298 pages, illustrated, $8^1/_2$ by 6 inches, cloth, $3.00. Gives the operating engineer, the plant superintendent, and the manager information necessary for the successful and economical selection and operation of steam turbines. Covers installation, lubrication, testing, and maintenance, with special attention to the economics of steam-turbine operation. Revised to conform to current practice, with a new chapter describing the engineering principles involved in turbine selection and heat balance.

TECHNICAL EXPOSITION. By L. M. Oliver. McGraw-Hill Book Company, New York, 1940. 193 pages, charts, $8^1/_2$ by $5^1/_2$ inches, cloth, $1.50. An advanced English text for engineers, presents a series of basic expository problems, with assignments for students, and a full discussion of theory and practice in preparing research papers and reports. Includes also business letter writing, vocabulary, and punctuation.

FESSENDEN, BUILDER OF TOMORROWS. By H. M. Fessenden. Coward-McCann, Inc., New York, 1940. 362 pages, illustrated, 9 by 6 inches, cloth, $3.00. The life and work of one of the American pioneers in radio communication are described by his wife. His other technical achievements include submarine signalling and detection, the generation and storage of power, and many articles on mathematical, physical, and electrical subjects. He also carried on research on the pre-deluge civilizations. Bibliography.

THE DEVELOPMENT OF MATHEMATICS. By E. T. Bell. McGraw-Hill Book Company, New York and London, 1940. 583 pages, $9^1/_2$ by 6 inches, cloth, $4.50. An account of the part played by mathematics in the evolution of civilization, describing the main principles, methods, and theories of mathematics that have survived, from about 4000 B.C. to 1940 A.D. Besides outlining the development of the leading ideas, the author explains the mathematics involved. Antiquarian interest is subordinated to exposition of things still alive in mathematics.

GRAPHS, HOW TO MAKE AND USE THEM. By A. Arkin and R. R. Colton. Revised edition. Harper and Brothers, New York and London, 1940. 236 pages, illustrated, $9^1/_2$ by 6 inches, cloth, $3.00. An introductory work which explains all the usual methods of graphic representation, outlining general principles and proper equipment for graph construction, and a wide variety of uses in business, economics, engineering, and other fields.

TORCH OF CIVILIZATION. The Story of Man's Conquest of Darkness. By M. Luckiesh. G. P. Putnam's Sons, New York, 1940. 269 pages, illustrated, $8^1/_2$ by $5^1/_2$ inches, cloth, $3.00. Following a discussion of the history of artificial light and its influence on developing civilization, the author describes in detail modern light sources. Separate chapters are devoted to gas flames and mantles, electric arcs, glowing filaments, luminous vapors, and fluorescent sources. The relations of light with sight, art, life, and health are also discussed.

STORAGE BATTERIES. By G. W. Vinal. Third edition. John Wiley and Sons, New York, 1940. 464 pages, illustrated, 9 by 6 inches, cloth, $5.00. Standard textbook on the theory of batteries, charging methods and equipment, care of batteries, and remedies for troubles encountered. The physical and chemical properties of storage battery materials are discussed, and manufacturing methods are described. Chapter on present-day uses for storage batteries. Revised.

THOMAS' REGISTER OF AMERICAN MANUFACTURERS. 31st edition, December 1940. Thomas Publishing Company, New York, Boston, Philadelphia, San Francisco, Toronto, Canada, 1941. 5,000 pages, illustrated, $14^1/_2$ by 9 inches, cloth, $10.00 to former subscribers, $15.00 to new subscribers. This huge annual directory of American manufacturers has its customary three main sections: the classified directory of products (with index) in which the firms are listed, with capital ratings, geographically under each product; the alphabetical list of manufacturers, giving addresses, subsidiaries, branches, etc.; and the trade name index. The innovation, introduced in the previous edition, of assigning arbitrary numbers to advertisers, including a "key" index, has been expanded in the present volume.

TRENDS IN INDUSTRIAL PENSIONS (Industrial Relations Monograph Number 5). By M. W. Latimer and K. Tufel. Industrial Relations Counselors, New York, 1940. 88 pages, tables, $9^1/_2$ by 6 inches, paper, $1.00. The objectives of this monograph, which analyzes some 350 active company pension plans, are: first, to determine whether the characteristics and trends of pension systems have changed in the last seven years, and, if so, in what direction; second, to analyze the growth or decline and the present extent of the voluntary pension movement; and third, to consider the adaptation of private pension systems to governmental old-age insurance legislation. The numerical findings of the investigation appear in a group of tables.

WELDING METALLURGY. Volumes I and II. By O. H. Henry and G. E. Claussen. American Welding Society, New York, 1940. 359 pages, illustrated, 8 by 5 inches, cloth, $1.50. Intended to familiarize members of the welding industries, including fabricators and designers, with the metallurgical aspects of the welding process, this book deals with the structure, properties, and composition of welded materials. It shows how the steel is affected by varied conditions of heat and stress, explains heat-treatment procedure and points out the way in which metallurgy can be used to control the welding process.

ATM (Archiv für technisches Messen) 111, 112, 113, September, October, November 1940. R. Oldenbourg, Munich and Berlin, pages T97–119, F3–5, illustrated, 12 by $8^1/_2$ inches, paper, 1.50 rm. each. Three numbers of a monthly publication containing classified articles upon various types of apparatus and methods for technical measurements. Certain numbers also contain descriptions of specific instruments manufactured by German companies.

APPLIED CHEMISTRY FOR ENGINEERS. By E. S. Gyngell. Edward Arnold and Company, London; Longmans, Green and Company, New York, 1940. 328 pages, illustrated, 9 by $5^1/_2$ inches, cloth, $4.00. Deals with the chemistry of materials and processes used by the engineer. Major topics discussed are fuels and combustion, metallic corrosion, paints and varnishes, water treatment and sewage disposal, cements, and lubrication. Selected bibliographies.

HOISTING MACHINERY. By W. H. Atherton. Technical Press, London, 1940. 314 pages, illustrated, 10 by 6 inches, cloth, 32s 6d. Deals with the design, construction, maintenance, and uses of the types of material-handling equipment that perform intermittent short-range movements: cranes, derricks, grabs, skip hoists, stackers, telphers, and transporters. Literature references in text and in a brief bibliography.